TWENTIETH FLIGHT ANNIVERSARY NUMBER

AVIATION

The Oldest American Aeronautical Magazine

DECEMBER 17, 1923 Issued Weekly PRICE 10 CENTS

Twenty years after the Wright brothers' first successful flights—Typical tractor biplane of today

VOLUME XV

NUMBER 25

SPECIAL FEATURES

ORIGINAL WRIGHT AIRPLANE DESCRIBED

THE FLYING EXPERIMENTS AT KITTY HAWK

SIR GEORGE CAYLEY'S WORK IN AERONAUTICS

NAVAL FLIGHT EXPEDITION INTO ARCTIC REGIONS

THE GARDNER, MOFFAT CO., INC.
HIGHLAND, N. Y.
225 FOURTH AVENUE, NEW YORK

Entered as Second-Class Matter, Nov. 22, 1920, at the Post Office at Highland, N. Y. under Act of March 3, 1879.

PUBLISHER'S NEWS LETTER

Twenty years is a short span of time in the history of a scientific achievement. In the life of an industry it is much longer. Twenty years in the telephone, automobile or radio industries have established them as industrial units and large permanent groups in the commercial world. The aviation industry has passed through several periods of development during its short twenty years of growth. Unfortunately, it has not been one of continuous expansion. Nevertheless the progress made has in it great promise for the future.

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The early period of promotion of this new invention was largely in the nature of exhibition flying. The Wrights and the other early pioneers were quick to recognize the intense interest of the public to witness exhibitions of flying and most of the early machines were devoted to that work. The manufacturing of airplanes at this early period was largely to supply this need. It was in these early days that the Wrights offered to throw open to the American people the rights to their patents for what now appears to be the insignificant sum of $100,000. That this offer was not accepted is an evidence of the lack of foresight of those interested in aeronautics at that time.

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The second period was largely devoted to the fortifying of the patent situation by everyone interested in aviation. As is the case in all new arts, claims were disputed and litigation ensued. But, nevertheless, there was development work going on all the time. Foreign progress in this period far outstripped our work, so that when the Great War came the American airplane constructors were unprepared to handle the unprecedented demand for aircraft.

* * * *

The third period was the great expansion from 1914 to 1918 during the war. First, the orders came from abroad for raw materials, parts and to a certain extent airplanes. Then, when the United States entered the war, the rush came for everything pertaining to aircraft. The demand was so great that factories in other lines were turned to the manufacture of airplanes and airplane parts and accessories. But with the armistice came the end of this period.

* * * *

The fourth period has been from 1919 to date, when the expanded manufacturing facilities were put through the difficult processes of contraction. Many aircraft companies have disappeared altogether and those that are left are mere shadows of the large organizations that were built up during the war. Many attempts have been made to develop some form of commercial aviation, but with the exception of the Air Mail, there has been very little accomplished that can truly be said to be on a sound business basis. In other words, the aircraft industry has now reached a condition where it is almost entirely dependent on government business.

* * * *

The consoling side of the present outlook is the undeniable fact that American aircraft engineering has made commendable progress and in many particulars leads the world. The twenty years have built up an appreciation of the public to the necessity of aerial defense. Given the support that they should receive, the next few years will show great advances in our governmental air services both in equipment and number of personnel. This will mean a larger aeronautical industry entirely aside from the uses of commercial air transport.

* * * *

It is to the use of aircraft in aerial transportation that the aircraft industry must look for a substantial growth in the future. Government business is too precarious to serve as a solid foundation for industrial success. The next twenty years will bring with them a realization of the hopes of those who have been waiting and working patiently for the era of aerial transportation. Then and then only will the utility of the Wright Brothers invention reach its logical goal. These peace-loving young men of Dayton never intended their invention to be turned into a war machine of terrible destruction. They and everyone else have hoped that this new means of transportation could be turned to benefit mankind by its peacetime uses.

DECEMBER 17, 1923 **AVIATION** VOL. XV. NO. 25

Published every Monday

CONTENTS

THE GARDNER, MOFFAT COMPANY, Inc., *Publishers*

Address all correspondence to

225 FOURTH AVENUE, NEW YORK

Publication office

HIGHLAND, N. Y.

Subscription price: Four dollars per year. Single copies ten cents. Canada, five dollars. Foreign, six dollars a year.

Issued every Monday. Forms close ten days previously. Entered as second-class matter Nov. 22, 1920, at the Post Office at Highland, N. Y., under act of March 3, 1879.

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Vol. XV DECEMBER 17, 1923 No. 25

The Twentieth Flight Anniversary

On the publication date of this issue twenty years have elapsed since the epoch making day when the brothers Orville and Wilbur Wright solved the problem of mechanical flight with a power driven machine, heavier than air, built to their own designs and piloted by themselves. Four flights, each under full control of the man on board, were made with the aeronautical Wright airplane over the desolate sand dunes of Kitty Hawk, N. C., on Dec. 17, 1903. The longest of these flights lasted slightly less than a minute and covered a distance of approximately three-fifths of a mile. The problem of airplane flight, which had baffled countless experimenters for a century, was solved to the imperishable glory of America.

This momentous event marks one of the greatest and most tenaciously fought for accomplishments of the human race. The earliest records, reaching back into the dim past of Man's upward struggle on the path of progress, show that countless generations ago human beings dreamed of emulating the swift flight of birds. In the ancient mythologies gods and demons were endowed with the gift of flight as an attribute of supreme power. For humans to think of building wings for themselves was considered sacrilegious and called for the extreme punishment. Even in the more enlightened ages, when the mechanical arts began developing, the idea of human flight was commonly associated with the powers of darkness. Experiments which machines that would liberate mankind from the bondage of gravity were, for this reason, but rarely made in public, and records of those made in private were seldom kept. Hence, our knowledge of ancient flying experiments is extremely fragmentary.

Only with the advent of modern engineering methods and scientific research, in the nineteenth century, was the problem of mechanical flight given serious and continuing attention by some fleet spirits who cheerfully braved the ridicule which had now taken the place of ancient superstition. It was the aviation pioneers of this century, Sir George Cayley, Wenham, Stringfellow, Penaud, Langley, Lilienthal and Chanute, who laid the rough foundations of the modern theory of mechanical flight. These men definitely knew from model experiments that flight with machines heavier than air was possible; they knew what a full sized airplane required to make it fly and why it would fly provided it could be made to leave the ground. And yet, when the nineteenth century came to its close no airplane had flown as yet. To bring about this accomplishment, two essential problems remained to be solved. One was stability in flight, the difficulty of which had been anticipated by some of these pioneers, but not solved. The other was the question of a power plant light enough to be susceptible of use in an airplane.

It will remain the undying fame of the Wright brothers to have fully gauged these difficulties when they approached the problem of human flight, and of having overcome them in the incredibly short span of four years. After having familiarized themselves with the operation of gliders in the manner shown by Lilienthal and Chanute, and having mastered the problem of stability by a judicious combination of control surfaces, as disclosed by accurate wind tunnel work, they proceeded to build their first motor driven airplane. Inability to obtain from the automobile industry an engine light enough for their purpose caused them to construct their own airplane motor together with the propellers and the necessary transmission gear. And when the machine was assembled and tested, it flew under full control of the pilot, just as they had anticipated.

What the invention of the airplane will ultimately mean to the world, can as yet but dimly be visualized. We have already witnessed, in the greatest war of the human race, the application of the flying machine to the manifold requirements of military science. We now see it expand beyond the frontiers of auxiliary warfare set to it by those steeped in age long traditions, and assume the role of a new agency of independent warfare.

But however important a part airplanes will play in future wars, it is in connection with commercial activities that their greatest immediate scope lies. The carrying by airplane of mails, express matter and special types of freight as well as of passengers, though still in its formative stage, already constitutes an important branch of human activity. Aerial photography and surveying, skywriting, exploration and relief work are other fields where the airplane is usefully employed in ever growing numbers. Thus, twenty years after its invention, the airplane can truly be said to have become a well nigh indispensable instrument of civilization.

The Naval Arctic Air Expedition

WONDERFUL as has been the progress of aviation during the past twenty years, as exemplified by such spectacular feats as the non-stop flights across the Atlantic Ocean and across the greater breadth of the United States nothing could perhaps better indicate the advance made in this art than the proposed American naval air expedition into the Arctic.

Though the plans of the expedition have been made public only in the merest outline, the statement that heavier-than air craft and lighter-than-air craft will both participate in this great venture is warmly welcomed. We have always held that airplanes and airships are complementary to one another, in war as well as in peace. Their combined employment for exploring a vast unknown region adjacent to the North Pole will make available interesting data regarding the manner in which airplanes and airships stand up under the strenuous conditions of an arctic exploration. This information will readily be applicable to the commercial and military operation of aircraft and so be of considerable value to all users and makers of aircraft.

The Twentieth Anniversary of Mechanical Flight

Two Authoritative Accounts of the Wright Brothers' Flying Experiments

On Dec. 17, 1903, at Kitty Hawk, N. C., for the first time in the world's history, a machine heavier than air rose from the ground under its own power, covered a certain distance in controlled horizontal flight and returned safely to earth with the man who had guided its progress through the air. The original airplane, studied, designed and built—including the power plant—by the brothers Wilbur and Orville Wright of Dayton, Ohio, had thus made its maiden flight.

Orville piloted the plane on this flight, then Wilbur took hold of the controls and repeated the performance with the same success. Before the day was over, four flights had been accomplished, the longest of which covered a distance of 852 ft., the time of flight being 59 sec. This momentous date marks the opening chapter of the Era of Aviation, the full significance of which is as yet hardly realized at large.

In commemoration of the twentieth anniversary of this epoch making event, which falls on the publication date of this issue, AVIATION is printing below two authoritative accounts of the Wright brothers' first successful flights and of the preliminary experiments leading up to this accomplishment.

It was hoped to secure from Orville Wright a more detailed account of his and his brother Wilbur's work on their solving the problem of mechanical flight. But the Wright brothers never were prolific writers, which will be regretted by posterity, for the few articles they contributed on aeronautics disclose a marked ability of expressing the mechanics of flight in terms both lucid and concise. Their reluctance to put their experiences into writing was humorously justified by Wilbur during his flying demonstration in France, in 1908, when he said: "The only bird that talks is the parrot, and he is not a high flier."

This sentence explains why there is so little authoritative information which could be considered a true story of the dawn of mechanical flight. However, in a letter to the Editor of AVIATION, Orville Wright writes as follows:—

"The only statement ever put out either by Wilbur or myself intended to be a Story of Mechanical Flight was the article in the September, 1908, Century Magazine, entitled "The Wright Brothers' Aeroplane, by Orville and Wilbur Wright." I prepared this article while Wilbur was in Europe, but as I used a number of expressions taken from his writings, I added his name as one of the authors. This is the only article that I know of that gives a statement (though only in outline) of the work done in producing the first flying machine."

This is the story printed below by courtesy of Century Magazine. Following it will be found a detailed account of the first power flights made at Kitty Hawk, N. C., which was contributed by Orville Wright to Flying (New York) of December, 1913.—EDITOR.

The Wright Brothers' Aeroplane

By ORVILLE and WILBUR WRIGHT

Reprinted from "Century Magazine" September, 1908

Though the subject of aërial navigation is generally considered new, it has occupied the minds of men more or less from the earliest ages. Our personal interest in it dates from our childhood days. Late in the autumn of 1878, our father came into the house one evening with some object partly concealed in his hands, and before we could see what it was, he tossed it into the air. Instead of falling to the floor, as we expected, it flew across the room till it struck the ceiling, where it fluttered awhile, and finally sank to the floor. It was a little toy known to scientists as a "hélicoptère," but which we, with sublime disregard for science, at once dubbed a "bat." It was a light frame of cork and bamboo, covered with paper, which formed two screws, driven in opposite directions by rubber bands under torsion. A toy so delicate lasted only a short time in the hands of small boys, but its memory was abiding.

Several years later we began building these hélicoptères for ourselves, making each one larger than that preceding. But, to our astonishment, we found that the larger the "bat," the less it flew. We did not know that a machine having only twice the linear dimensions of another would require eight times the power. We finally became discouraged, and returned to kite-flying, a sport to which we had devoted so much attention that we were regarded as experts. But as we became older, we had to give up this fascinating sport as unbecoming to boys of our ages.

It was not till the news of the sad death of Lilienthal reached America in the summer of 1896 that we again gave more than passing attention to the subject of flying. We then studied with great interest Chanute's "Progress in Flying Machines," Langley's "Experiments in Aerodynamics," the "Aeronautical Annuals" of 1895, 1896, and 1897, and several pamphlets published by the Smithsonian Institution, especially articles by Lilienthal and extracts from Moullard's "Empire of the Air." The larger works gave us a good understanding of the nature of the flying problem, and the difficulties in past attempts to solve it, while Moullard and Lilienthal, the great missionaries of the flying cause, infected us with their own unquenchable enthusiasm, and transformed idle curiosity into the active zeal of workers.

Two Schools of Aviation

In the field of aviation there were two schools. The first, represented by such men as Professor Langley and Sir Hiram Maxim, gave chief attention to power flight, the second, represented by Lilienthal, Moullard and Chanute, to soaring flight. Our sympathies were with the latter school, partly from impatience at the wasteful extravagance of mounting delicate and costly machinery on wings which no one knew how to manage, and partly, no doubt, from the extraordinary charm and enthusiasm with which the apostles of soaring flight set forth the beauties of sailing through the air on fixed wings, deriving the motive power from the wind itself.

The balancing of a flyer may seem, at first thought, to be a very simple matter, yet almost every experimenter had found in this the one point which he could not satisfactorily master. Many different methods were tried. Some experimenters placed the center of gravity far below the wings, a

Orville Wright

Wilbur Wright

the belief that the weight would naturally seek to remain at the lowest point. It was true, that, like the pendulum, it tended to seek the lowest point; but also, like the pendulum, it tended to oscillate in a manner destructive of all stability. A more satisfactory system, especially for lateral balance, was that of arranging the wings in the shape of a broad **V**, to form a dihedral angle, with the center low and the wing-tips elevated. In theory this was an automatic system, but in practice it had two serious defects: first, it tended to keep the machine oscillating; and, second, its usefulness was restricted to calm air.

In a slightly modified form the same system was applied to the fore-and-aft balance. The main aeroplane was set at a positive angle, and a horizontal tail at a negative angle, while the center of gravity was placed far forward. As in the case of lateral control, there was a tendency to constant undulation, and the very forces which caused a restoration of balance in calms, caused a disturbance of the balance in winds. Notwithstanding the known limitations of this principle, it has been embodied in almost every prominent flying-machine which has been built.

The Problem of Stability

After considering the practical effect of the dihedral principle, we reached the conclusion that a flyer founded upon it might be of interest from a scientific point of view, but could be of no value in a practical way. We therefore resolved to try a fundamentally different principle. We would arrange the machine so that it would not tend to right itself. We would make it as inert as possible to the effects of change of direction or speed, and thus reduce the effects of wind-gusts to a minimum. We would do this in the fore-and-aft stability by giving the aeroplanes a peculiar shape, and in the lateral balance, by arching the surfaces from tip to tip, just the reverse of what our predecessors had done. Then by some suitable contrivance, actuated by the operator, forces should be brought into play to regulate the balance.

Lilienthal and Chanute had guided and balanced their machines by shifting the weight of the operator's body. But this method seemed to us incapable of expansion to meet large conditions, because the weight to be moved and the distance of possible motion were limited, while the disturbing forces steadily increased, both with wing area and with wind velocity. In order to meet the needs of large machines, we wished to employ some system whereby the operator could vary at will the inclination of different parts of the wings, and thus obtain from the wind forces to restore the balance which the wind itself had disturbed. This could easily be done by using wings capable of being warped, and by supplementary adjustable surfaces in the shape of rudders. As the forces obtainable for control would necessarily increase in the same ratio as the disturbing forces, the method seemed capable of expansion to an almost unlimited extent. A happy device was discovered whereby the apparently rigid system of superposed surfaces, invented by Wenham, and improved by Stringfellow and Chanute, could be warped in a most unexpected way, so that the aeroplanes could be presented on the right and left sides at different angles to the wind. This, with an adjustable, horizontal front rudder, formed the main feature of our first glider.

The period from 1885 to 1900 was one of unexampled activity in aeronautics, and for a time there was high hope that the age of flying was at hand. But Maxim, after spending $100,000, abandoned the work; the Ader machine, built at the expense of the French Government, was a failure; Lilienthal and Pilcher were killed in experiments; and Chanute and many others, from one cause or another, had relaxed their efforts, though it subsequently became known that Professor Langley was still secretly at work on a machine for the United States Government. The public, discouraged by the failures and tragedies just witnessed, considered flight beyond the reach of man, and classed its adherents with the inventors of perpetual motion.

We began our active experiments at the close of this period, in October, 1900, at Kitty Hawk, North Carolina. Our machine was designed to be flown as a kite, with a man on board, in winds of from fifteen to twenty miles an hour. But, upon trial, it was found that much stronger winds were re-

quired to lift it. Suitable winds not being plentiful, we found it necessary, in order to test the new balancing system, to fly the machine as a kite without a man on board, operating the levers through cords from the ground. This did not give the practice anticipated, but it inspired confidence in the new system of balance.

In the summer of 1901 we became personally acquainted with Mr Chanute. When he learned that we were interested in flying as a sport, and not with any expectation of recovering the money we were expending on it, he gave us much encouragement. At our invitation, he spent several weeks with us at our camp at Kill Devil Hill, four miles south of Kitty Hawk, during our experiments of that and the two succeeding years. He also witnessed our flight of the power machine near Dayton, Ohio, in October, 1904

The 1901 Glider

The machine of 1901 was built with the shape of surface used by Lilienthal, curved from front to rear like the segment of a parabola, with a curvature 1/12 the depth of its coed, but to make doubly sure that it would have a sufficient lifting capacity when flown as a kite in fifteen- or twenty-mile winds, we increased the area from 165 square feet, used in 1900, to 308 square feet—a size much larger than Lilienthal, Pilcher, or Chanute had deemed safe. Upon trial, however, the lifting capacity again fell very far short of calculation, so that the idea of securing practice while flying as a kite, had to be abandoned. Mr Chanute, who witnessed the experiments, told us that the trouble was not due to poor construction of the machine. We saw only one other explanation—that the tables of air-pressures in general use were incorrect.

We then turned to gliding—coasting down hill on the air—as the only method of getting the desired practice in balancing a machine. After a few minutes' practice we were able to make glides of over 300 feet, and in a few days were safely operating in twenty-seven-mile* winds. In these experiments we met with several *unexpected* phenomena. We found that, contrary to the teachings of the books, the center of pressure on a curved surface traveled backward when the surface was inclined, at small angles, more and more edgewise to the wind. We also discovered that in free flight, when the wing on one side of the machine was presented to the wind at a greater angle than the one on the other side, the wing with the greater angle descended, and the machine turned in a direction just the reverse of what we were led to expect when flying the machine as a kite. The larger angle gave more resistance to forward motion, and reduced the speed of the wing on that side. The decrease in speed more than counterbalanced the effect of the larger angle. The addition of a fixed vertical vane in the rear increased the trouble, and made the machine absolutely dangerous. It was some time before a remedy was discovered. This consisted of movable rudders working in conjunction with the twisting of the wings. The details of this arrangement are given in our patent specifications, published several years ago.

Groping in the Dark

The experiments of 1901 were far from encouraging. Although Mr. Chanute assured us that, both in control and in weight carried per horse-power, the results obtained were better than those of any of our predecessors, yet we saw that the calculations upon which all flying-machines had been based were unreliable, and that all were simply groping in the dark. Having set out with absolute faith in the existing scientific data, we were driven to doubt one thing after another, till finally, after two years of experiment, we cast it all aside, and decided to rely entirely upon our own investigations. Truth and error were everywhere so intimately mixed as to be undistinguishable. Nevertheless, the time expended in preliminary study of books was not misspent, for they gave us a good general understanding of the subject, and enabled us at the outset to avoid effort in many directions in which results would have been hopeless.

The standard for measurements of wind-pressures is the force produced by a current of air of one mile per hour velocity striking square against a plane of one square-foot area. The practical difficulties of obtaining an exact measurement of this force have been great. The measurements by different recognized authorities vary fifty per cent. When the simplest of measurements presents so great difficulties, what shall be said of the troubles encountered by those who attempt to find the pressure at each angle as the plane is inclined more and more edgewise to the wind? In the eighteenth century the French Academy prepared tables giving such information, and at a later date the Aëronautical Society of Great Britain made similar experiments. Many persons likewise published measurements and formulas; but the results were so discordant that Professor Langley undertook a new series of measurements, the results of which form the basis of his celebrated work, "Experiments in Aërodynamics." Yet a critical examination of the data upon which he based his conclusions as to the pressures at small angles shows results so various as to make many of his conclusions little better than guess work.

To work intelligently, one needs to know the effects of a multitude of variations that could be incorporated in the surfaces of flying-machines. The pressures on squares are different from those on rectangles, circles, triangles or ellipses, arched surfaces differ from planes, and vary among themselves according to the depth of curvature, true area

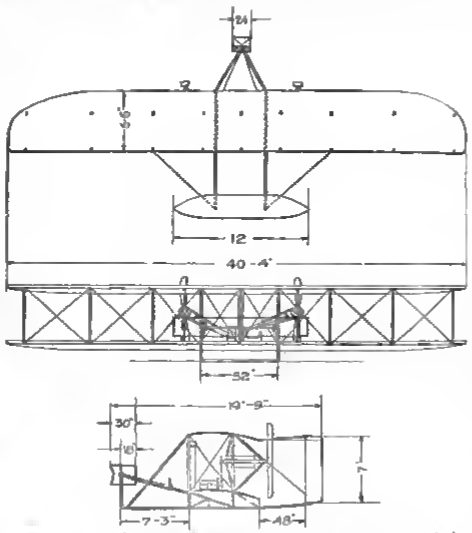


Fig. 1. Outline drawings of the original Wright airplane (1903), with 12 hp. engine

differ from parabolas, and the latter differ among themselves, thick surfaces differ from thin, and surfaces thicker in one place than another vary in pressure when the positions of maximum thickness are different, some surfaces are most efficient at one angle, others at other angles. The shape of the edge also makes a difference, so that thousands of combinations are possible in so simple a thing as a wing.

Wind Tunnel Work

We had taken up aëronautics merely as a sport. We reluctantly entered upon the scientific side of it. But we soon found the work so fascinating that we were drawn into it deeper and deeper. Two testing-machines were built, which we believed would avoid the errors to which the measurements of others had been subject. After making preliminary measurements on a great number of different-shaped surfaces, to

*The gliding flights were all made against the wind. The difficulty in high winds is in maintaining balance, not in traveling against the wind.

Fig. 2. Three-quarter rear view of the original Wright airplane, at Kitty Hawk, N. C., December, 1903. Orville Wright standing in front

secure a general understanding of the subject, we began systematic measurements of standard surfaces, so varied in design as to bring out the underlying causes of differences noted in their pressures. Measurements were tabulated on nearly fifty of these at all angles from zero to 45 degrees, at intervals of 2½ degrees. Measurements were also secured showing the effects on each other when surfaces are superposed, or when they follow one another.

Some strange results were obtained. One surface, with a heavy roll at the front edge, showed the same lift for all angles from 7½ to 45 degrees. A square plane, contrary to the measurements of all our predecessors, gave a greater pressure at 30 degrees than at 45 degrees. This seemed so anomalous that we were almost ready to doubt our own measurements, when a simple test was suggested. A weather-vane, with two planes attached to the pointer at an angle of 80 degrees with each other, was made. According to our tables, such a vane would be in unstable equilibrium when pointing directly into the wind; for if by chance the wind should happen to strike one plane at 39 degrees and the other at 41 degrees, the plane with the smaller angle would have the greater pressure, and the pointer would be turned still farther out of the course of the wind until the two vanes again secured equal pressures, which would be at approximately 30 and 50 degrees. But the vane performed in this very manner. Further corroboration of the tables was obtained in experiments with a new glider at Kill Devil Hill the next season.

The Gliding Flights of 1902

In September and October, 1902, nearly one thousand gliding flights were made, several of which covered distances of over 600 feet. Some, made against a wind of thirty-six miles an hour, gave proof of the effectiveness of the devices for control. With this machine, in the autumn of 1903, we made a number of flights in which we remained in the air for over a minute, often soaring for a considerable time in one spot, without any descent at all. Little wonder that our unscientific assistant should think the only thing needed to keep it indefinitely in the air would be a coat of feathers to make it light!

With accurate data for making calculations, and a system of balance effective in winds as well as in calms, we were now in a position, we thought, to build a successful power-flyer. The first designs provided for a total weight of 600 pounds, including the operator and an eight horse-power motor. But, upon completion, the motor gave more power than had been estimated, and this allowed 150 pounds to be added for strengthening the wings and other parts.

Our tables made the designing of the wings an easy matter; and as screw-propellers are simply wings traveling in a spiral course, we anticipated no trouble from this source. We had thought of getting the theory of the screw-propeller from the marine engineers, and then by applying our tables of air-pressures to their formulas of designing air-propellers suitable for our purpose. But so far as we could learn, the marine engineers possessed only empirical formulas, and the exact action of the screw-propeller, after a century of use, was still very obscure. As we were not in a position to undertake a long series of practical experiments to discover a propeller suitable for our machine, it seemed necessary to obtain such a thorough understanding of the theory of its reactions as would enable us to design them from calculation alone. What at first seemed a simple problem became more complex the longer we studied it. With the machine moving forward, the air flying backward, the propellers turning sidewise, and nothing standing still, it seemed impossible to find a starting-point from which to trace the various simultaneous reactions. Contemplation of it was confusing. After long arguments, we often found ourselves in the ludicrous position of each having been converted to the other's side, with no more agreement than when the discussion began.

It was not till several months had passed, and every phase of the problem had been thrashed over and over, that the various reactions began to untangle themselves. When once a clear understanding had been obtained, there was no difficulty in designing suitable propellers, with proper diameter, pitch, and area of blade, to meet the requirements of the flyer. High efficiency in a screw-propeller is not dependent upon any particular or peculiar shape, and there is no such thing as a "best" screw. A propeller giving a high dynamic efficiency when used upon one machine, may be almost worthless when used upon another. The propeller should in every case be designed to meet the particular conditions of the machine to which it is to be applied. Our first propellers,

built entirely from calculation, gave in useful work 66 per cent. of the power expended. This was about one third more than had been secured by Maxim or Langley.

The First Power Flights

The first flights with the power-machine were made on the 17th of December, 1903. Only five persons besides ourselves were present. These were Messrs. John T. Daniels, W. S. Dough, and A. D. Etheridge of the Kill Devil Life Saving Station, Mr. W. C. Brinkley of Manteo, and Mr. John Ward of Naghead. Although a general invitation had been extended to the people living within five or six miles, not many were willing to face the rigors of a cold December wind in order to see, as they no doubt thought, another flying-machine *not* fly. The first flight lasted only twelve seconds, a flight very

Fig. 3. First flight of the original Wright airplane, at Kitty Hawk, N. C., Dec. 17, 1903—The machine, piloted by Orville Wright, has just left the monorail on which it gathered flying speed under the combined thrust of its propellers and of a launching catapult. Wilbur Wright is alongside of machine.

modest compared with that of birds, but it was, nevertheless, the first in the history of the world in which a machine carrying a man had raised itself by its own power into the air in free flight, had sailed forward on a level course without reduction of speed, and had finally landed without being wrecked. The second and third flights were a little longer, and the fourth lasted fifty-nine seconds, covering a distance of 852 feet over the ground against a twenty-mile wind.

After the last flight the machine was carried back to camp and set down in what was thought to be a safe place. But a few minutes later, while we were engaged in conversation about the flights, a sudden gust of wind struck the machine, and started to turn it over. All made a rush to stop it, but we were too late. Mr. Daniels, a giant in stature and strength, was lifted off his feet, and falling inside, between the surfaces, was shaken about like a rattle in a box as the machine rolled over and over. He finally fell out upon the sand with nothing worse than painful bruises, but the damage to the machine caused a discontinuance of experiments.

Flying Experiments at Dayton

In the spring of 1904 through the kindness of Mr. Torrence Huffman of Dayton, Ohio, we were permitted to erect a shed, and to continue experiments on what is known as Huffman Prairie at Simms Station, eight miles east of Dayton. The new machine was heavier and stronger, but similar to the one flown at Kill Devil Hill. When it was ready for its first trial, every newspaper in Dayton was notified and about a dozen representatives of the press were present. Our only request was that no pictures be taken, and that the reports be unsensational, so as not to attract crowds to our experiment-grounds. There were probably fifty persons altogether on the ground. When preparations had been completed, a wind of only three or four miles was blowing,—insufficient for starting on so short a track,—but since many had come a long way to see the machine in action, an attempt was made. To add to the other difficulty, the engine refused to work properly. The machine, after running the length of the track, slid off the end without rising into the air at all. Several of the newspaper men returned the next day, but were again disappointed. The engine performed badly, and after a glide of only sixty feet, the machine came to the ground. Further trial was postponed till the motor could be put in better running condition. The reporters had now, no doubt, lost confidence in the machine, though their reports, in kindness, concealed it. Later, when they heard that we were making flights of several minutes' duration, knowing that longer flights had been made with airships, and not knowing any essential difference between airships and flying-machines, they were but little interested.

We had not been flying long in 1904 before we found that the problem of flying equilibrium had not as yet been entirely solved. Sometimes, in making a circle, the machine would turn over sidewise despite anything the operator could do, although, under the same conditions in ordinary straight flight, it could have been righted in an instant. In one flight, in 1905, while circling around a honey locust-tree at a height of about fifty feet, the machine suddenly began to turn up on one wing, and took a course toward the tree. The operator, not relishing the idea of landing in a thorn-tree, attempted to reach the ground. The left wing, however, struck the tree at a height of ten or twelve feet from the ground, and carried away several branches, but the flight, which had already covered a distance of six miles, was continued to the starting point.

The Improved Wright Airplane

The causes of these troubles—too technical for explanation here—were not entirely overcome till the end of September, 1905. The flights then rapidly increased in length, till experiments were discontinued after the 5th of October, on account of the number of people attracted to the field. Although made on a ground open on every side, and bordered on two sides by much traveled thoroughfares, with electric cars passing every hour, and seen by all the people living in the neighborhood for miles around, and by several hundred others, yet these flights have been made by some newspapers the subject of a great "mystery."

A practical flyer having been finally realized, we spent the years 1906 and 1907 in constructing new machines and in business negotiations. It was not till May of this year that experiments (discontinued in October, 1905) were resumed at Kill Devil Hill, North Carolina. The recent flights were made to test the ability of our machine to meet the requirements of a contract with the United States Government to furnish a flyer capable of carrying two men and sufficient fuel supplies for a flight of 125 miles, with a speed of forty miles an hour. The machine used in these tests was the same one with which

the flights were made at Simms Station in 1905, though several changes had been made to meet present requirements. The operator assumed a sitting position, instead of lying prone, as in 1905, and a seat was added for a passenger. A larger motor was installed, and radiators and gasoline reservoirs of larger capacity replaced those previously used. No attempt was made to make high or long flights.

In order to show the general reader the way in which the machine operates, let us fancy ourselves ready for the start. The machine is placed upon a single rail track facing the wind, and is securely fastened with a cable. The engine is put in motion, and the propellers in the rear whir. You take your seat at the center of the machine beside the operator. He slips the cable, and you shoot forward. An assistant who has been holding the machine in balance on the rail, starts forward with you, but before you have gone fifty feet the speed is too great for him, and he lets go. Before reaching the end of the track the operator moves the front rudder, and the machine lifts from the rail like a kite supported by the pressure of the air underneath it. The ground under you is at first a perfect blur, but as you rise the objects become clearer. At a height of one hundred feet you feel hardly any motion at all, except for the wind which strikes your face. If you did not take the precaution to fasten your hat before starting you have probably lost it by this time. The operator moves a lever: the right wing rises, and the machine swings about to the left. You make a very short turn, yet you do not feel the sensation of being thrown from your seat, so often experienced in automobile and railway travel. You find yourself facing toward the point from which you started. The objects on the ground now seem to be moving at much higher speed, though your perceive no change in the pressure of the wind on your face. You know then that you are traveling with the wind. When you near the starting-point, the operator stops the motor while still high in the air. The machine coasts down at an oblique angle to the ground, and after sliding fifty or a hundred feet comes to rest. Although the machine often lands when traveling at a speed of a mile a minute, you feel no shock whatever, and cannot, in fact, tell the exact moment at which it first touched the ground. The motor close beside you kept up an almost deafening roar during the whole flight, yet in your excitement, you did not notice it till it stopped!

Our experiments have been conducted entirely at our own expense. In the beginning we had no thought of recovering what we were expending, which was not great, and was limited to what we could afford for recreation. Later, when a successful flight had been made with a motor, we gave up the business in which we were engaged, to devote our entire time and capital to the development of a machine for practical uses. As soon as our condition is such that constant attention to business is not required, we expect to prepare for publication the results of our laboratory experiments, which alone made an early solution of the flying problem possible.

How We Made The First Flight

By ORVILLE WRIGHT

Reprinted from "Flying," December 1913

The flights of the 1902 glider had demonstrated the efficiency of our system of maintaining equilibrium, and also the accuracy of the laboratory work upon which the design of the glider was based. We then felt that we were prepared to calculate in advance the performance of machines with a degree of accuracy that had never been possible with the data and tables possessed by our predecessors. Before leaving camp in 1902 we were ready at work on the general design of a new machine which we proposed to propel with a motor.

Developing the Power Plant

Immediately upon our return to Dayton, we wrote to a number of automobile and motor builders, stating the purpose for which we desired a motor, and asking whether they could furnish one that would develop eight-brake horsepower, with a weight complete not exceeding 800 lb. Most of the companies answered that they were too busy with their regular business to undertake the building of such a motor for us, but one company replied that they had motors rated at 8 bp., according to the French system of ratings, which weighed only 135 lb., and that if we thought that this motor would develop enough power for our purpose, they would be glad to sell us one. After an examination of the particulars of this motor, from which we learned that it had but a single cylinder of 4-in. bore and 5-in. stroke, we were afraid that it was much overrated. Unless the motor would develop a full 8 h. bp. it would be useless for our purpose.

Finally we decided to undertake the building of the motor ourselves. We estimated that we could make one of four cylinders with 4-in. bore and 4-in. stroke, weighing not over 200 lb., including all accessories. Our only experience up to that time in the building of gasoline motors had been in the construction of an air-cooled motor, 5-in. bore and 7-in. stroke, which was used to run the machinery of our small workshop. To be certain that four cylinders of the size we had adopted (4 in. × 4 in.) would develop the necessary 8 hp., we first fitted them into a temporary frame of simple and cheap construction. In just six weeks from the time the design was started, we had the motor on the block testing its power. The ability to do this so quickly was largely due to the enthusiastic and efficient services of C. E. Taylor, who did all the machine work in our shop for the first as well as for the succeeding experimental machines. There was no provision for lubricating either cylinders or bearings while the motor was running. For that reason it was not possible to run it more than a minute or two at a time. In these short tests the motor developed about 9 hp. We were then satisfied that, with proper lubrications and better adjustments, a little more power could be expected. The completion of the motor accordingly to drawing was, therefore, proceeded with at once.

While Mr. Taylor was engaged with this work, Wilbur and I were busy in completing the design of the machine itself. The preliminary tests of the motor having convinced us that more than 8 hp. would be assured, we felt free to add enough weight to build a more substantial machine than we had originally contemplated.

Our tables of air pressures and our experience in flying the 1902 glider, enabled us, we thought, to calculate exactly the thrust necessary to sustain the machine in flight. But to design a propeller that would give this thrust with the power we had at our command, was a matter we had not as yet seriously considered. No data on air propellers was available, but we had always understood that it was not a difficult matter to secure an efficiency of 50 per cent with marine propellers. All that would be necessary would be to learn the theory of the operation of marine propellers from books on marine engineering, and then substitute air pressures for water pressures. Accordingly we secured several such books from the Dayton Public Library. Much to our surprise, all the formulae on propellers contained in these books were of an empirical nature. There was no way of adapting them to calculations of aerial propellers. As we could afford neither the time or expense of a long series of experiments to find by trial a propeller suitable for our machine, we decided to rely more on theory than was the practice with marine engineers.

It was apparent that a propeller was simply an airplane traveling in a spiral course. As we could calculate the effect of an airplane traveling in a straight course, why should we not be able to calculate the effect of one traveling in a spiral course? At first glance this does not appear difficult, but on further consideration it is hard to find even a point from which to make a start, for nothing about a propeller, or the

medium in which it acts, stands still for a moment. The thrust depends upon the speed and the angle at which the blade strikes the air, the angle at which the blade strikes the air depends upon the speed at which the propeller is turning, the speed the machine is traveling forward, and the speed at which the air is slipping backward; the slip of the air backwards depends upon the thrust exerted by the propellers and the amount of air acted upon. When any one of these changes, it changes all the rest, as they are all interdependent upon one another. But these are only a few of the many factors that must be considered and determined in calculating and designing propellers.

Our minds became so obsessed with it that we could do little other work. We engaged in numerable discussions, and often after an hour or so of heated argument, we would discover that we were as far from agreement as when we started, but that both had changed to the other's original position in the discussion. After a couple of months of this study and discussion, we were able to follow the various reactions in their intricate relations long enough to begin to understand them. We realized that the thrust generated by a propeller when standing stationary was no indication of the thrust when in motion. The only way to really test the efficiency of a propeller would be to actually try it on the machine.

Reason for Two Propellers

For two reasons we decided to use two propellers. In the first place we could, by the use of two propellers, secure a reaction against a larger quantity of air, and at the same time use a larger pitch angle than was possible with one propeller, and in the second place by having the propellers turn in opposite directions, the gyroscopic action of one would neutralize that of the other. The method we adopted of driving the propellers in opposite directions by means of chains is now too well known to need description here. We decided to place the motor to one side of the man, so that in case of a plunge head first, the motor could not fall upon him. In our gliding experiments we had had a number of experiences in which we had landed upon one wing, but the crushing of the wing had absorbed the shock, so that we were not uneasy about the motor in case of a landing of that kind. To provide against the machine rolling over forward in landing, we designed skids like sled runners, extending out in front of the main surfaces. Otherwise the general construction and operation of the machine was to be similar to that of the 1902 glider.

When the motor was completed and tested, we found that it would develop 16 hp for a few seconds, but that the power rapidly dropped till, at the end of a minute, it was only 12 hp. Ignorant of what a motor of this size ought to develop, we were greatly pleased with its performance. More experience showed us that we did not get one half of the power we should have had.

With 12 hp at our command, we considered that we could permit the weight of machine with operator to rise to 750 or 800 lb., and still have as much surplus power as we had originally allowed for in the first estimate of 550 lb.

Before leaving for our camp at Kitty Hawk we tested the chain drive for the propellers in our shop at Dayton, and found it satisfactory. We found, however, that our first propeller shafts, which were constructed of heavy gage steel tubing, were not strong enough to stand the shocks received from a gasoline motor with light fly wheel, although they would have been able to transmit three or four times the power if uniformly applied. We therefore built a new set of shafts of heavier tubing, which we tested and thought to be abundantly strong.

Assembling the Airplane

We left Dayton Sept. 23, 1903, and arrived at our camp at Kill Devil Hill on Friday, the 25th. We found there provisions and tools, which had been shipped by freight several weeks in advance. The building, erected in 1901 and enlarged in 1902, was found to have been blown by a storm from its foundation posts a few months previously. While we were awaiting the arrival of the shipment of machinery and parts from Dayton, we were busy putting the old building in repair, and erecting a new building to serve as a workshop for assembling and housing the new machine.

Just as the building was being completed, the parts and materials for the machines arrived simultaneously with one of the worst storms that had visited Kitty Hawk in years. The storm came on suddenly blowing 30 to 40 mi./hr. It increased during the night, and the next day was blowing over 75 mi./hr. In order to save the tar-paper roof, we decided it would be necessary to get out in this wind and nail down more securely certain parts that were especially exposed. When I ascended the ladder and reached the edge of the roof, the wind caught under my large coat, blew it up around my head and bound my arms till I was perfectly helpless. Wilbur came to my assistance and held down my coat while I tried to drive the nails. But the wind was so strong I could not guide the hammer and succeeded in striking my fingers as often as the nails.

The next three weeks were spent in setting the motor-machine together. On days with more favorable winds we gained additional experience in handling a flier by gliding with the 1902 machine, which we had found in pretty good condition in the old building, where we had left it the year before.

Mr. Chanute and Dr. Spratt, who had been guests in our camp in 1901 and 1902, spent some time with us, but neither one was able to remain to see the test of the motor machine, on account of the delays caused by trouble which developed in the propeller shafts.

Problem of Power Transmission

While Mr. Chanute was with us, a good deal of time was spent in discussion of the mathematical calculations upon which we had based our machine. He informed us that, in designing machinery, about 20 per cent was usually allowed in the transmission of power. As we had allowed only 5 per cent, a figure we had arrived at by some crude measurements of the friction of one of the chains when carrying only a very light load, we were much alarmed. More than the whole surplus in power allowed in our calculations would, according to Mr. Chanute's estimate, be consumed in friction in the driving chains. After Mr. Chanute's departure, we suspended one of the drive chains over a sprocket, hanging bags of sand on either side of the sprocket of a weight that would be approximately equal to the pull that would be exerted on the

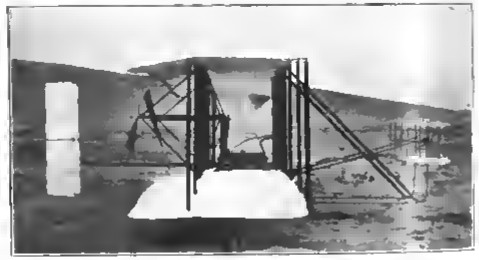


Fig. 4 Side view of the original Wright airplane, at Kitty Hawk, N. C., December, 1903

chains when driving the propellers. By measuring the extra amount of weight needed on one side to lift the weight on the other, we calculated the loss in transmission. This indicated that the loss of power from this source would be only 5 per cent as we originally estimated. But while we could see no serious error in this method of determining the loss, we were very uneasy until we had a chance to run the propellers with the motor to see if we could get the estimated number of turns.

The first run of the motor on the machine developed a flaw in one of the propeller shafts which had not been discovered in the test at Dayton. The shafts were sent at once to Dayton for repair and were not received again until Nov. 20, having been gone two weeks. We immediately put them in the

machine and made another test. A new trouble developed. The sprockets which were screwed on the shafts, and locked with nuts of opposite thread, persisted in coming loose. After many futile attempts to get them fast, we had to give it up and went to bed much discouraged. After a night's rest we got up in better spirits and resolved to try again.

While in the bicycle business we had become well acquainted with the use of hard tire cement for fastening tires on the rims. We had once used it successfully in repairing a stop watch after several watchsmiths had told us it could not be repaired. If tire cement was good for fastening the hands on a stop watch, why should it not be good for fastening the sprockets on the propellers of a flying machine? We decided to try it. We heated the shafts and the sprockets, melted cement into the threads, and screwed them together again. This trouble was over. The sprockets stayed fast.

Just as the machine was ready for test, bad weather set in. It had been disagreeably cold for several weeks, so cold that we could scarcely work on the machine some days. But now we began to have rain and snow and a wind of 25 to 30 mi./hr. blew for several days from the north. While we were delayed by the weather we arranged a mechanism to measure automatically the duration of the flight from the time the machine started to move forward to the time it stopped, the distance traveled through the air in that time, and the number of revolutions made by the motor and propeller. A stop watch took the time, an anemometer measured the air traveled through, and a counter took the number of revolutions made by the propellers. The watch, anemometer and revolution counter were all automatically started and stopped simultaneously. From data thus obtained we expected to prove or disprove the accuracy of our propeller calculations.

On Nov. 28, while giving the motor a run indoors, we thought we again saw something wrong with one of the propeller shafts. On stopping the motor, we discovered that one of the tubular shafts had cracked!

Immediate preparation was made for returning to Dayton to build another set of shafts. We decided to abandon the use of tubes, as they did not afford enough spring to take up the shocks of premature or missed explosions of the motor. Solid tool-steel shafts of smaller diameter than the tubes previously used were decided upon. These would allow a certain amount of spring. The tubular shafts were many times stronger than would have been necessary to transmit the power of our motor if the strains upon them had been uniform. But the large hollow shafts had no spring in them to absorb the unequal strain.

First Attempt at Power Flight

Wilbur remained in camp while I went to get the new shafts. I did not get back to camp again until Friday, the 11th of December. Saturday afternoon the machine was again ready for trial, but the wind was so light, that a start could not have been made from level ground with the run of only 60 ft. permitted by our monorail track. Nor was there enough time before dark to take the machine to one of the hills, where, by placing the track on a steep incline, sufficient speed could be secured for starting in calm air.

Monday, Dec. 14, was a beautiful day, but there was not enough wind to enable a start to be made from level ground about camp. We therefore decided to attempt a flight from the side of the big Kill Devil Hill. We had arranged with the members of the Kill Devil Life Saving Station, which was located a little over a mile from our camp, to inform them when we were ready to make the first trial of the machine. We were soon joined by J. T. Daniels, Robert Westcott, Thomas Beachem, W. S. Dough and Uncle Benny O'Neal, of the station, who helped us get the machine to the hill, a quarter mile away. We laid the track 150 ft. up the side of the hill on a 9 deg. slope. With the slope of the track, the thrust of the propellers and the machine starting directly into the

Fig. 5 The Wright camp at Kitty Hawk, N. C., in 1903, with the original Wright airplane. The large building, with Wilbur Wright standing at the entrance, was used for housing the machine, while the small building served as a workshop and living quarters

wind, we did not anticipate any trouble in getting up flying speed on the 60 ft. monorail track. But we did not feel certain the operator could keep the machine balanced on the track.

When the machine had been fastened with a wire to the track, so that it could not start until released by the operator, and the motor had been run to make sure it was in condition, we tossed up a coin to decide who should have the first trial. Wilbur won. I took a position at one of the wings intending to balance the machine as it ran down the track. But when the restraining wire was slipped, the machine started off so quickly I could stay with it only a few feet. After a 35- to 40-ft. run, it lifted from the rail. But it was allowed to turn up too much. It climbed a few feet, stalled and then settled to the ground near the foot of the hill 105 ft. below. My stop watch showed that it had been in the air just 3½ sec. In landing the left wing touched first. The machine swung around, dug the skids into the sand and broke one of them. Several other parts were also broken, but the damage to the machine was not serious. While the test had shown nothing as to whether the power of the motor was sufficient to keep the machine up, since the landing was made many feet below the starting point, the experiment had demonstrated that the method adopted for launching the machine was a safe and practical one. On the whole we were much pleased.

Various Difficulties

Two days were consumed in making repairs, and the machine was not ready again till late in the afternoon of the 16th. While we had it out on the track in front of the building, making the final adjustments, a stranger came along. After looking at the machine a few seconds he inquired what it was. When we told him it was a flying machine he asked whether we intended to fly it. We said we did, as soon as we had a suitable wind. He looked at it several minutes longer and then, wishing to be courteous, remarked that it looked as if it would fly, if it had a "suitable wind." We were much amused for, no doubt, he had in mind the recent 75-mile gale when he repeated our words, "a suitable wind!"

During the night of Dec 16, 1903, a strong cold wind blew from the north When we arose on the morning of the 17th, the puddles of water, which had been standing around camp since the recent rain, were covered with ice The wind had a velocity of 10 to 12 m /sec (22 to 27 mi /hr) We thought it would die down before long, and so remained indoors the early part of the morning But when 10 o'clock arrived, and the wind was as brisk as ever, we decided that we had better get the machine out and attempt a flight We hung out the signal for the men of the Life Saving Station We thought that hy facing the machine into a strong wind, there might to be no trouble in launching it from the level ground about

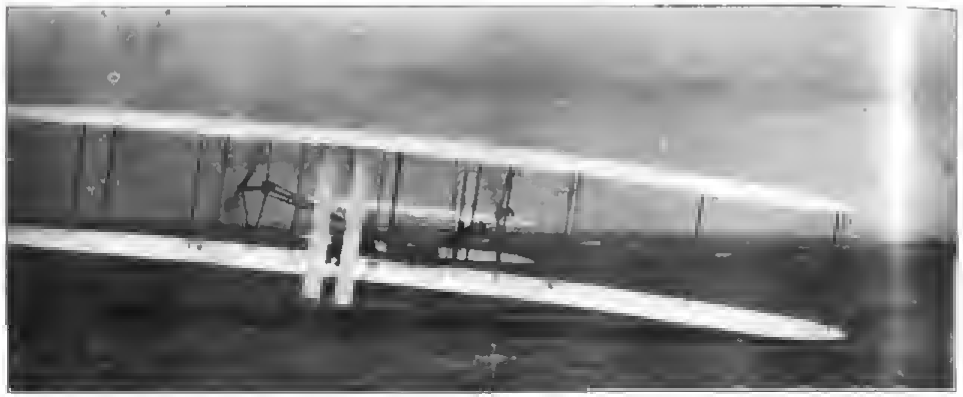


Fig. 6 An exciting moment during the third flight of the original Wright airplane, at Kitty Hawk, N. C., Dec 17, 1903— The right wing of the machine nearly touching the ground after leaving the launching rail

camp. We realized the difficulties of flying in so high a wind, but estimated that the added dangers in flight would be partly compensated for hy the slower speed in landing

We laid the track on a stretch of ground about one-hundred feet north of the new building The hiting cold wind made work difficult, and we had to warm up frequently in our living room, where we had a good fire in an improvised stove made of a large carbide can. By the time all was ready. J. T. Daniels, W. S. Dough, and A. D. Etheridge, members of the Kill Devil Life Saving Station, W. C Brinkley, of Manteo, and Johnny Moore, a boy from Nags Head, had arrived

We had a "Richard" hand anemometer with which we measured the velocity of the wind Measurements made just before starting the first flight showed velocities of 11 to 12 m /sec., or 24 to 27 mi /hr Measurements made just before the last flight gave between 9 and 10 mi /sec. One made just after showed a little over 8 mi /sec The records of the Government Weather Bureau at Kitty Hawk gave the velocity of the wind between the hours of 10 30 and 12 00 o'clock, the time during which the four flights were made, as averaging 27 mi /hr at the time of the first flight and 24 mi /hr at the time of the last.

With all the knowledge and skill acquired in thousands of flights in the last twenty years, I would not think today of making my first flight on a strange machine in a twenty-seven-mile wind, even if I knew that the machine had already been flown and was safe After these years of experience I look with amazement upon our audacity in attempting flights with a new and untried machine under such circumstances. Yet faith in our calculations and the design of this first machine, based upon our tables of air pressures, seemed by months of laboratory work, and confidence in our system of control developed hy three years of actual experience in balancing machine, racing a 27-mi wind, started very slowly. Wilbur was able to stay with it till it lifted from the track after a 40 ft run. One of the Life Saving men snapped the camera for us, taking the picture just as the machine had reached the end of the track and had risen to a height of about two feet. Tha slow forward speed of the machine over the ground is clearly shown in the picture hy Wilbur's attitude He stayed along beside the machine without any effort.

The course of the flight up and down was exceedingly erratic, partly due to the irregularity of the air, and partly to lack of experience in handling this machine. The control of the front rudder was difficult on account of its being balanced too near the center Thus gave a tendency to turn itself when started; so that it turned too far on one side and then too far on the other As a result the machine would rise suddenly to about 10 ft, and then as suddenly dart for the ground. A sudden dart when a little over 100 ft from the end of the track, or a little over 120 ft. from the point at which it rose into the air, ended the flight As the velocity of the wind was over 35 ft./sec and the speed of the machine over the ground against the wind 10 ft./sec., the speed of the machine relative to the air was over 45 ft /sec., and the length of the flight was equivalent to a flight of 540 ft. made in calm air This flight lasted only 12 sec, hut it was nevertheless tha first in the history of the world in which a machine carrying a man had raised itself by its own power into the air in full flight, had sailed forward without the reduction of speed, and had finally landed at a point as high as that from which it started

With the assistances of our visitors we carried the machine back to the track and prepared for another flight The stiff wind, however, had chilled us alt through, so that before gliders in the air had convinced us that the machine was capable of lifting and maintaining itself in the air, and that, with a little practice, it could be safely flown.

Orville's First Flight

Wilbur, having used his turn in the unsuccessful attempt of the 14th, the right of the first trial now belonged to me. After running the motor a few minutes to heat it up, I released the wire that held the machine to the track, and the machine started forwaed into the wind. Wilbur ran at the side of the machine, holding the wing to balance it on the track. Unlike the start on the 14th, made in a calm, the

*See Fig 3 p 736—EDITOR

Carreer of Orville Wright

WRIGHT, ORVILLE, Aeronautical Engineer, born, Dayton, Ohio, Aug 19, 1871, son of Bay Milton Wright and Susan Catherine (Koerner) Wright; unmarried

Educated: Public schools, Dayton, Ohio Cedar Rapids, Ia., and Richmond, Ind. Honorary degrees: Doctor of Technical Science, 1909, Royal Technical College, Munich Master of Science, 1909, Earlham College, LL D 1910 Oberlin College D Sc. 1915, Trinity College D Sc. 1917, University of Cincinnati M.A. 1919, Yale University, Medals Gold Medal of the Aero Club al France, 1908 Gold Medal of the Aero Club of the United Kingdom (Great Britain) 1908 Gold Medal of the Academy of Sports of France, 1908 Gold Medal, presented by the Aeronautical Society of Great Britain, 1908, Gold Medals from the State of Ohio, 1909 from Congress of the United States, 1909, from the City of Dayton, 1909 from Aero Club of America, 1909, Langley Medal awarded by the Smithsonian Institution 1910 Cross of Chevalier of the Legion of Honor awarded by the French Republic, 1909 Gold Medal awarded by the Institute of France, Academy of Sciences 1909, Bronze Medal of the International Peace Society, Collier Trophy awarded by the Aero Club of America for the year 1913 in recognition of the development and demonstration of the automatic stabilizer, Elliott Cresson Medal awarded by the Franklin Institute of Philadelphia, 1914 Albert Medal awarded by The Royal Society of Arts, 1917 John Fritz Medal awarded by a Board appointed by the American Society of Civil Engineers American Institute of Mining Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers, 1920

Professional; 1889 1899 printing and publishing 1892 1903 bicycle manufacturing and repairing 1905 1907 negotiations for the sale of airplane five months spent in Europe in 1907 1908, sold French patents to Compagnie Generale de Navigation Aerienne, 1909, formation of Flug maschine Wright Gesellschaft in Germany and The Wright Company in America 1909 1912 vice-president, The Wright Company 1912 1915 President, The Wright Company, Chairman of the Board of Directors of The British Wright Company, organized in 1913. 1915 1920, consulting engineer

Aeronautical Activities: First man to fly in power driven heavier than air machine, 1903 with his brother Wilbur experimented with model airplanes using wing warping for the first time for lateral balance 1902, experimented with man carrying glider at Kitty Hawk N C 1901 1902 designed wind tunnel and balances and made measurements of the lift and drill at angles from zero to 45 deg. of several hundred aerofoils also measured the center of pressure on several of these the system of control given in the original Wright patent was completed at this time, 1903 built motor-driven airplane with which on Dec 17, 1903 at Kitty Hawk N C the first flight in history was made 1904 1905 continued experiments with motor-driven planes near Dayton Ohio, 1905 1907 developed the four cylinder vertical engine later used on the Wright Model "B", 1908, tested machine on contract with the United States Government at Fort Meyer, Va, during which tests the first flight of one hour's duration was made these flights were terminated by an accident in which Lieutenant Selfridge was killed and Mr Wright seriously injured 1909 joined his brother Wilbur in France and Italy completed the tests for the American Government in July then returned to Europe flying during several months in Germany 1910 1915 designing and testing airplanes automatic stabilizer, etc 1919, aeronautic research in wind tunnel laboratory at Dayton, Ohio appointed member of the National Advisory Committee for Aeronautics by President Wilson

Flying Rating Aero Club of France License No 14 aviation certificate No 4 of the Aero Club of America issued under F A I Rules

Member: Exact number of Clubs [illegible] The Franklin Institute, Society of Automotive Engineers Academy of Political and Social Science Honorary Membership: Aero Club of Sarthe France, Aero Club of America, Aeronautical Society of America, Aero Club of the United Kingdom (Great Britain); Royal Aeronautical Society of Great Britain; Oesterreichischer Flugtechnischer Verein Vienna Der Verein Deutscher Flugtechniker Berlin Columbia University Aero Club Harvard Aeronautical Society, American Society of Mechanical Engineers, Cleveland Aviation Club, Aero Club of Texas Aero Club of Dayton, Ohio Society of New York Royal Aeronautical Society (Great Britain)

Present Occupation: Aeronautical research

Address 15 North Broadway home, Harmon and Park Aves Dayton, Ohio

attempting a second flight, we all went to the building again to warm up.

Wilbur's First Flight

At twenty minutes after eleven Wilbur started on the second flight. The course of this flight was much like that of the first, very much up and down. The speed was faster than the first flight, due to the lesser wind The duration of the flight was less than a second longer than the first, hut the distance covered was about 75 ft. greater.

Twenty minutes later the third flight started. This one was steadier than the first one an hour before. I was proceeding along pretty well when a sudden gust from the right lifted the machine up 12 to 15 ft. and turned it up sidewise in an alarming manner It began a lively sidling off to the left. I warped the wings to try to recover the lateral balance and at the same time pointed the machine down to reach the ground as quickly as possible. The lateral control was more effective than I had imagined and before I reached the ground the right wing was lower than the left and struck first. The time of this flight was fifteen seconds and the distance over the ground a little over 200 ft.

Wilbur started the fourth and last flight at just 12 o'clock. The first few hundred feet were up and down as before, hut by the time 300 ft. had been covered, the machine was under much better control. The course for the next four or five hundred feet had bnt little undulation. However, when out about 800 ft. the machine began pitching again, and, in one of its darts downward, struck the ground. The distance over the ground was measured and found to be 852 ft ; the time of the flight 59 sec The frame supporting the front rudder was badly broken, but the main part of the machine was not injured at all. We estimated that the machine could he put in condition for flight in a day or two.

While we were standing aronnd discussing this last flight, a sudden strong gust of wind struck the machine and began to turn it over Everybody made a rush for it Wilbur who was at one end, seized it in front, Mr. Daniels and I, who were behind, tried to stop it by holding to the rear uprights. All our efforts were in vain The machine rolled over and over Daniels, who had retained his grip, was carried along with it, and was thrown about head over heels inside of the machine. Fortunately he was not seriously injured, though badly bruised in falling about against the motor, chain guides, etc The ribs in the surfaces of the machines were broken, the motor injured and the chain guides badly bent, so that all possibility of further flights with it for that year were at an end

Regarding Collier Trophy Award

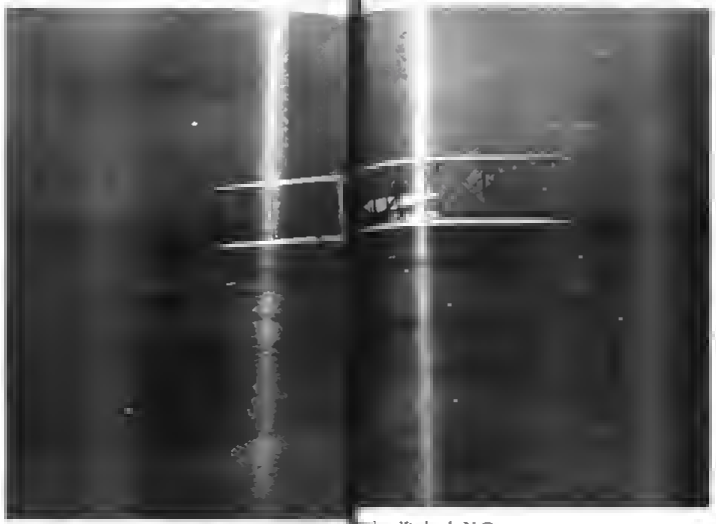
The Collier Trophy Committee of the National Aeronautic Association will meet on Jan 15, 1924, to view and pass upon the claims made hy various contenders for this trophy

For your information, we are attaching hereto the provisions of deed of gift and past awards for this trophy In order that claims may be heard, it is absolutely necessary that they he in the hands of this Committee not later than Saturday, Jan 12 All claims must he attested before a notary public and seal attached In case special demonstrations are desired, wood should immediately be sent to the Collier Trophy Committee, which will, if possible, assign a representative as witness.

Declarations of private tests and demonstrations must be signed hy two responsible and representative witnesses These men shall be outside of the organization of the contender, such as municipal, military or naval officers or other men of prominence and standing

The Collier Trophy Committee consists of Orville Wright, Col F P Lahm, Dr George W. Lewis, Porter Adams and B Russell Shaw.

The Collier Trophy, donated hy Robert J Collier, Esq , to be awaeded annually by the National Aeronautic Association for the greatest achievement in aviation in America, the value of which has been thoroughly demonstrated by the actual use during the preceding year



First successful flight, hand-l… plane—Kittyhawk, N. C., 1903

Wright Assembly Plant—Kittyhawk, N. C., 1903

THE ARC OF TIME

Twenty years ago the genius a… Wilbur Wright culminated i… heavier-than-air plane. These … itance of this company.

Ten years ago through co… practice the organization of W… ing and manufacturing of ai… to meet the military requiren…

Today this great organizati… and principles established by… years ago are furthering the a… plane and engine design for mi…

…d perseverence of Orville and … the first successful flight of a … asic patents are a direct inher-

…rect aeronautical engineering …ght made possible the design- …lane engines in huge volume …nts of the Great War.

…n by strict adherence to ideals … the Wright Brothers twenty …vancement of aviation in both …tary and commercial purposes.

WRIGHT AERONAU… …TICAL CORPORATION …ney, U.S.A.

Paterson, N…

Wright Plant—Paterson, New Jersey. 1923

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Sir George Cayley's Work in Aeronautics

Early Pioneer Originated Airplane Flight Theory and Anticipated Metal-Hull Airship

Among the world's great aeronautical pioneers Sir George Cayley holds a place the importance of which is not generally realized, if it is not totally overlooked, by the contemporary flying world His principal claim to lasting fame lies in his remarkable ability to grasp and expound the basic principles underlying the theory of power flight with machines both lighter and heavier than air at a time when contemporary knowledge of the subject was, almost without an exception, a tangled web of fallacious speculations. As a pioneer of the airplane, Sir George ranks particularly high, for he was the first, as far as is known, to reduce the problem of mechanical flight to terms of engineering, and to test—in 1809—the results of his laboratory work by means of gliding experiments

The twentieth anniversary of the definite solution of the problem of mechanical flight by the Wright brothers makes it therefore particularly timely to recall the main points of the work done by Cayley in furtherance of air navigation. The account which follows is taken from an excellent paper read by J. E. Hodgson before the Newcomen Society in London, England, which was published by The Journal of the Royal Aeronautical Society *of August, 1923* —EDITOR.

Sir George Cayley was born at his ancestral home Brompton Hall, in the North Riding of Yorkshire, on Dec 27, 1773 The bent of his mind toward scientific pursuits became apparent in early years, and it is said that his interest in aerial navigation was inspired when he was not more than 10 or 12 years old by the Montgolfiers' discovery of the balloon. As he himself relates his first experiment in aeronautics was made with a Chinese "flying top" in the year 1796, and it is significant of his steadfast attachment to the subject, that as late as 1854, he sent a description of an improved type of this aerial toy to the distinguished French aeronaut and writer, Dupuis-Delcourt In 1795 he married Sarah Walker (the only daughter of Rev George Walker, F R S, and President of the Literary and Philosophical Society of Manchester), by whom he had a large family

Early Contributions on Aeronautics

His first published contributions on "Aerial Navigation" (mechanical flight) appeared in Nicholson's *Journal of Philosophy* in 1809 10, in 1816-17 he expounded in the pages of Tilloch's *Philosophical Magazine* his ideas on navigable balloons, a subject to which he returned in letters published in the *Mechanics Magazine* in 1837 Further contributions (suggested by the discussion on Henson's "Aerial Carriage") to the latter periodical in 1843, with two articles in the Bulletin of the "Société Aérostatique et Météorologique de France" in 1853, complete the record of his extant writings. It can hardly be doubted that these cover but a small part of all the investigations, calculations and experiments made on aeronautical matters over many years. Of his life and scientific labors apart from aeronautics little is known Politics and the affairs of the family estates doubtless occupied much of his time, but it is clear that his chief concerns were science and engineering in general, and aeronautics in particular. He built a shed or outhouse at Brompton in which he conducted a large number of experiments on the application of electricity as a motive power, and on the development of the gas engine In the latter direction he contributed to Nicholson's Journal in 1807 a "Description of an engine for affording mechanical power from air expanded by heat," but though constructed at Newcastle on what Cayley termed "a considerable scale," it proved unsuccessful

Later in life he accepted the congenial office of chairman of the old Polytechnic Institution, while in 1852 he stood successfully as Parliamentary candidate for the borough of Scarborough He retired after two years and died at Brompton Hall on Dec 15, 1857 †

Of Cayley's character it is difficult, from the meager knowledge available, to form a true conception, but the amplitude of his views on aerial navigation suggests a mind of great breadth of view, endowed with remarkable imaginative foresight For as early as 1809 he expressed complete confidance in the practicability and security of mechanical flight as a method of transport, at a speed exceeding that of the railway train, and by 1816-17 he was advocating the navigable balloon with even stronger conviction, as offering " a direct, swift and easy floatage from any one point to every other on the face of the globe" His large conception of air travel cannot be more forcibly expressed than in his own words "An uninterrupted navigable ocean," he said, "that comes to the threshold of every man's door, ought not to be neglected as a source of human gratification and advantage."

State of Contemporary Aerostatic Science

I pass to outline, as briefly as possible, the state of the science of aerostation, particularly with regard to the direction of control of balloons, at the time when Cayley first turned his attention to the subject It is well known that the balloon was invented by the brothers Montgolfier in 1783, and that in October of that year Pilâtre de Rozier first ascended into the air in a balloon of the Montgolfière type—that is a balloon inflated with hot-air rarefied by means of a fire burning a brazier In the following December this method of inflation was improved upon by J -A -C Charles, who introduced the use of hydrogen

It was realized almost at the outset, that the use of the balloon as a method of aerial travel would be greatly limited, unless it were possible to devise a method of control. Oars or wings, consisting of a light framework covered with silk or other material, were the first forms of mechanism designed to afford manual propulsive power, J P Blanchard, in March, 1784, being the first to experience—though not to admit—their inefficiency Other projects tried or suggested were forms of jet propulsion (by means of hot-air, on the principle of the aeolipyle of the ancients), or by the reaction of gunpowder exploded in the form of rockets. Yet another method—invented by David Bourgeois in 1784, which also engaged the attention of Montgolfier in France, and (at a slightly later date) of R L. Edgeworth and Cayley himself in Great Britain—involved the use of an adjustable plane surface fitted beneath the balloon, whereby to obtain some measure of control from the pressure of air on such plane during the rise or fall of the balloon

Of the great majority of these early schemes it need only be said that they were faulty in theory or fatile in application An important exception must be made, however, in the case of the theoretical examination of the principles involved, undertaken by J-B- Meusnier, equally distinguished in military, scientific and mechanical achievements. As early as December, 1783, he prepared a memoir in which he suggested the need of making the form ellipsoidal, and introduced the use of the air ballonet Meusnier's work and the drawings and plans which accompanied it, are very remarkable, as well in respect of form and the ballonet, as in his ideas of diagonal rope suspension of the car and in the application of air-screws—worked, of course, by manual power—for propulsion. The airship—it deserves to be so termed, if only for the fact that it was designed to be 260 ft in length—was never constructed, and the only contemporary test of the ballonet principle was in its profitless application to the elongated free balloon of the brothers Robert, in which they made ascents during July and September, 1784.

An air ballonet was, however, incorporated in the design of a "fish-formed" balloon invented in 1789 by Baron Scott, a French officer, who may possibly have taken his idea of shape from the so-called "Flying Fish" aerostatic machine exhibited in Cornhill in 1785, which there is reason to believe was the work of John Heole, son of Samuel Heole, watchmaker and mechanician, and (more notably) the friend of Dr Johnson. Scott's ideas more probably inspired S. J. Pauly, a Genevan gunsmith, who actually constructed a "fish-formed" dirigible which he tried with some measure of success at Secaux in 1802, deriving an inadequate propelling power from the use of wings or revolving oars. In 1815 he came to London, and with the financial help of Durs Egg, a noted London gunsmith, the "Dolphin Balloon" was commenced at Kensington. The envelope—about 90 ft. long—was made of layers of gold-beaters' skin, and it was to contain an air ballonet of 20 ft. in diameter, horizontal stability being maintained by means of an adjustable weight suspended between the tail of the balloon and the car. A more important feature was the intention to obtain "the propelling impetus" from "a kind of atmospheric steam engine, invented by Mr Colher." But financial and other difficulties proved insuperable, and "Egg's folly," as it was called by the cynics, was never completed It represents, however, in the main, the stage the navigable balloon had reached in Cayley's day, the chief features being the shape—tending toward streamline—the air ballonet to preserve that form, the suspension of a gondola or car beneath the envelope, and the suggested use of steam as a prime mover.

Cayley's Work on Dirigible Balloons

Coming to Cayley's own work on dirigible balloons, it has been already mentioned that his first published essays on the subject appeared in Tilloch's *Philosophical Magazine* during 1816-17 It is true that his earliest writings on aeronautics dealt with mechanical flight, but I take his contributions to "lighter-than-air" theory first, because his ultimate faith in the success of aerial navigation over the world's surface was based on the possibilities of the navigable balloon. He made this clear beyond dispute in one of his last letters on the subject He pointed out that it had been proved that elongated balloons of a large size were capable of being driven through calm air at a speed approaching that of the railway train, and could carry a considerable cargo by reason of their buoyancy From these premises he argued that "on a great scale, balloon floatage offers the most ready, efficient and safe means of aerial navigation." "Elongated balloons of large dimensions," he wrote in the same paper, "offer greater facilities for transporting men and goods through the air, than mechanical means alone, inasmuch as the whole weight is suspended in the air without effort . . . and when the invention is realized, it will abundantly supply the increasing locomotive wants of mankind." Moreover he gave prophetic utterance, with remarkable foresight, to the view which, after much ebbing and flowing, has in quite recent years received the support of distinguished aeronautical experts—the view that the relation of airships to airplanes is complementary and not competitive. "Mechanical flight," Cayley wrote in 1843, "seems more adapted for use on a much smaller scale, and for less remote distances, serving, perhaps, the same purpose that a boat does to a ship, each being essential to the other"*

Broadly speaking, it was Cayley's ability to grasp the basic scientific or mechanical principles underlying the theory of navigable balloons, rather than his skill as an inventor or designer, wherein lies his true greatness as a pioneer of the airship He was, for instance, one of the first to realize fully the practical significance of one of the main factors on which airship theory rests—namely, the physical law that "the surfaces (and hence the resistance) increase as the squares of the diameter of the balloon, whereas the capacity to contain gas (and hence the supporting power) increases as the cubes of the diameter." If it were not for that principle he knew quite well that the difficulties would be far greater As to the factors involved in the question of resistance, he pointed out (as indeed others had already done), that obviously the spherical form of the ordinary free balloon should be lengthened horizontally, thus diminishing the cross-section for the same volume, and he realized the desirability of dividing the gas into several compartments

With more originality he even suggested that dirigibles, "when used as permanent vehicles and on the true scale of magnitude, will probably be made of thin metallic sheets kept firm by condensation [that is pressure] with separate light bags of gas within." For a first experiment on these lines he suggested that Charles Green's large balloon—presumably the famous "Nassau Balloon" of 1836—should be requisitioned, and that two other balloons of smaller size should be "packed at opposite sides of this larger one," a suggestion which, however, was not tried Of greater interest in his early anticipation of some degree of rigidity, revealed in the proposal to guard against the then unknown laws of resistance offered by fluids to solid bodies, by means of "light poles and internal cross bracings of wire or cord," designed to preserve the shape of his elongated spheroidal balloon.

Moreover Cayley carefully considered the problems affecting the transmission of power from an engine suspended in a car beneath the envelope to the balloon itself—a point of particular moment in his own design owing to the need of keeping the boiler and furnace of the steam engine which he proposed to fit as far as possible below the envelope. As to his "prime mover," he had perforce to adopt the steam engine, but it is, I think, quite clear that he realized it was by no means an ideal form of power for the purpose, and there is reason to believe that his experiments, both with gas engines and electricity, were largely inspired by the idea of turning those sources of energy to account in aeronautics.

With regard to the fabric of the envelope, which necessitated, as Cayley laid down, a material "perfectly air-tight, light and strong," he suggested that the great expense of silk (covered with india-rubber varnish) would be prohibitive, and proposed as an alternative "double-cotton Indian rubber cloth," as invented in 1823 by Charles Macintosh for waterproof garments and air-tight cushions In this connection it is of interest to note that Cayley's work was not wholly theoretical, for in 1816 he refers to a cloth weighing ½ lb per sq ft. as used in "my experiments"

Cayley's Airship Designs

In his first design of an airship, as communicated (with accompanying plans) to Tilloch's *Philosophical Magazine* in 1816 17, he provided for a Montgolfière or hot-air balloon 300 ft. long, 45 ft. in elevation, and 90 ft wide, made of "woolen cloth" In form it was an elongated spheroid, with a conical head and a slight tapering toward the stern—on the axiom common among sailors, that a ship to sail well should have a "cod's head and a mackerel's tail"—and it was to be kept to its shape by the light poles and cross bracing before mentioned The impelling power was to be derived from the deviation obtained from the pressure of air on a passive plane surface, a wholly inadequate method, the idea of which, as Cayley admits, was derived from the plan described by John Evans a year earlier

In his next essay, Cayley goes far beyond his original ideas, and offers calculations based on the possibility of propelling an elongated balloon by wing waftage—that is, wings fitted to the sides of the car and actuated by mechanical power He expressed a preference for this (mistaken) form of propulsion as against "rotary wafts" or airscrews, mainly owing to the difficulty of "giving firm support and communicating motion to the latter," though admitting the advantage they afforded of uniform action This improved design was to be 144 ft long, with a lift of 163,000 lb, which reduced by the weight of the materials (1,700 lb) and of the engine, boiler, fuel, etc. (15,210 lb), would leave about 34 tons Stated in terms of performance, Cayley estimated that this would allow of this transportation of 50 men for 48 hr, or a voyage of 960 mi. in calm air

Further consideration of this "balloon of 50 tons" led him

†It must have been a great source of satisfaction to him to live to hear of the first successful flight of a steam-driven airship, accomplished by Henri Giffard, in 1852 near Paris—EDITOR.

*The importance Cayley attached to the advantages of the airship is revealed in the fact that while he first stated them in the *Mechanics Magazine*, March, 1837, he not only reprinted them (as an interpolation) but even put them in the final paragraph of his essay on mechanical flight, contributed to the same magazine in April, 1843

to comment on the difficulties involved in the "stupendous bulk"—difficulties arising from expenses of construction and inflation and difficulties in "disposing of them when not employed." He does not appear to have contemplated the construction of immense airship sheds, such as have been erected in recent years, for he made calculations on the "horizontal drag" of large balloons at anchor, from which he deduced that this drag diminishes with size and oblong structure. Indeed, at a later date he had done that "permanently-filled balloons would ride out storms when properly secured, without the danger of being driven to the earth or damaged."

Problem of the Prime Mover

In 1837 he revised the foregoing speculations in a lengthy communication to the *Mechanics Magazine*, wherein he sought to present considerations which would be "most conducive at present towards a final accomplishment of the aerial object in view." His elaboration of the "inclined plane" method of propulsion involved the combination of a large Montgolfière below and a smaller hydrogen balloon above, separated by the plane. But apart from the danger of such a combination—a danger experienced with fatal results in 1785 by Pilâtre du Rozier—the method was not worth even the brief consideration Cayley gave to it. Moreover, the twenty years or so which separated his essays had resulted in improvements in the steam engine, which by 1837 gave promise of greater power for weight. In this connection Cayley referred to the steam carriage of his friend Sir Goldsworthy Gurney, the engine of which he calculated would give one horse-power for 200 lb weight. But though he recognized that "lighter first movers than steam engines may be discovered, and made applicable to propelling balloons," he proceeded to take the case as he found it. With a hydrogen balloon of a similar shape to his original design, 90 ft. in diameter and 315 ft. long, he estimated there would be available for engine power, crew and cargo, a lift of about 29¼ tons. He further estimated that a balloon of this size would require an engine of 60 hp.

As to the application of propelling power, he still adhered to the idea of wings arranged in two tiers, but he also reverted to the idea of airscrews—"oblique vanes," as he said, "reversing the action of the sails of a windmill." As to the latter, he instanced the results of experiments made by the French Academy, which went to show that "a proper fulcrum or resistance for the engine power to work upon can be had at a velocity of 25 ft. per second." Finally, reckoning the engine, with fuel and water for four hours, at 510 lb per horsepower, and deducting also the weight of the "machinery for wafting," Cayley arrived at the conclusion that traveling at the designed speed of 14 m./hr. his balloon would have a useful load of about 9 tons.

Cayley never attempted the construction of a large navigable balloon, but we may well believe he was only deterred by reason of the great expense. This diffidently led him in 1816 to suggest experiments by public subscription, an appeal he renewed in 1837 in the form of a proposal to organize a "Society for Promoting Aerial Navigation." It was doubtless the indifference shown toward his proposals that led him to write in 1843—in words which, with some modification, are even today not wholly inapplicable to the prevailing attitude toward the airship—"I think it a national disgrace in these enlightened locomotive times not to realize by public subscription the proper scientific experiments, necessarily too expensive for any private purse, which would secure to this country the glory of being the first to establish the dry navigation of the universal ocean of the terrestrial atmosphere."

Contemporary Ideas on Mechanical Flight

Turning to the general conceptions of mechanical flight in Cayley's time, and the ideas which had led up to them, it may be said at once that there were only two points of view—the one from which flight was regarded as a matter of flapping wings, and the other as a matter of impossibility any way. The old, the very old idea of wings, was doubtless inspired by the natural, not to say obvious, analogy of the flight of birds, a sense in which the practicability of the thing was first expressed by Roger Bacon in the middle of the 13th century, while early in the 16th century the idea occupied the great mechanical genius of Leonardo da Vinci.

Indeed, broadly speaking, it is true to say that flight was invariably regarded in the light of the imaginary achievement credited by Francis Bacon to the inhabitants of his "New Atlantis," in 1627. "We imitate also the flight of birds," says the sage, in a marvellously prophetic recital of countless mechanical devices and scientific notions practised in that Utopian community. Those words held good for something like the next two hundred years, not only, indeed, as an expression of aims, but as a baneful conception which blocked other fields of speculation. For that reason it is unnecessary to enter into any detail, or to recall the endeavors—more numerous, probably, than is commonly realized—made during the 18th and 19th centuries to achieve flight by means of wings. Even in the years immediately preceding the discovery of the balloon, J-B. Blanchard was engaged in futile and fruitless attempts to construct a "flying vessell." Not that the study of the principles involved in bird flight was in itself profitless, on the contrary, Lilienthal himself regarded it as "the basis of aviation." But up to Cayley's day, and long after, those principles were not understood; they gave rise to the most varied and impossible speculations, and the blind attempts made to imitate their apparent characteristics diverted attention from the more strictly mechanical aspects of flight.

It is because Cayley was among the first to approach the problems of flight from the mechanical and not, so to speak, from the ornithological point of view, and because he first conducted "gliding" experiments on a considerable scale, that he deserves to stand among the great pioneers of aviation in the direct line between such names as Leonardo da Vinci in the 15th, and John Stringfellow in the 19th century.

Cayley's Work on Mechanical Flight

It has been seen that Cayley's first experiment in such matters was made as early as 1796 with a Chinese or aerial top (identical with the device exhibited before the French Academy of Sciences in 1784 by Launoy and Bienvenu), which served at once to illustrate the principle of the helicopter and the airscrew. Though but a toy of a few inches in length, its capacity to demonstrate certain elementary but important principles in aeronautics, made a lasting impression on Cayley's mind, and (as already mentioned) only three years before his death he sent to Dupuis-Delcourt a drawing of one which he had made—the best, he said, that he had ever seen, capable of rising 90 ft. in the air.

Having collected a body of "facts and practical observations in the course of much attention to the subject"—to use Cayley's own words—he published his first essays "On Aerial Navigation," dealing with the subject wholly from the point of view of mechanical flight, in the pages of *Nicholson's Journal* during 1809-10. The character of his observations and experiments is at once shown in his ability to grasp essential principles. His reflections on bird flight led him to the belief—confirmed by so great an observer as Charles Darwin nearly 25 years later—that flying required less exertion than was commonly supposed. But he categorically denounced the idea of flight by means of wings (worked by muscular effort) as ridiculous. In his clearly expressed conviction that mechanical flight was possible, and in his enunciation of the "whole problem" as contained in the simple but comprehensive formula, "To make a surface support a given weight by the application of power to the resistance of air," he is revealed as the earliest true pioneer of the airplane. He had perfect confidence in the practicability of transporting passengers and goods—the latter word is expressive of his large ideas—"more securely by air than by water, and with a velocity of from 20 to 100 miles per hour."

His earlier experiments in aerodynamics had revealed (the figures quoted are Cayley's calculations) that a surface of one square foot moving at a velocity of 11 538 ft./sec. generated a resistance equivalent to 4 oz., or at 17.16 it gave 8 oz. With some such data—obtained by an early form of "whirling table"—he proceeded to make gliding experiments, carried out over a number of years, on what he called "a considerable scale of magnitude"—apparently with a machine having a surface of 300 sq. ft.—and his enthusiastic description of one of the trial flights, made from the high ground behind Brompton Hall may be quoted as the first of its kind, and therefore historic and as in itself of great interest. "It was beautiful,"

he wrote in November, 1809, "to see the noble white *bird* sail majestically from the top of a hill to any given point of the plain below it, according to the set of the rudder, merely by its own weight, descending in an angle of about 15 per cent with the horizon." Cayley states that the upward lift of this gliding machine was at times so strong that anyone running forward in it against a light breeze would be raised from the ground for "several yards together."

Considered Many Problems

Even at this date Cayley's thoughts were also engaged on the question of propulsion, or the necessity of a "first mover" as he termed it. Realizing that a steam engine of the type invented by Boulton and Watt would be inadequate he looked more hopefully to the development of some such engine as was reported to have been designed by William Chapman of Newcastle—an early form of internal combustion engine with oil of tar as fuel. Evidently he intended to make some trial of a propelling apparatus with his glider, for he refers to the fact that an accident prevented his doing so.

He continued, however, to consider many other factors involved in mechanical flight—problems dealing with questions of normal velocity, the leverage on the wings, and the need for lightness in construction combined with strength. The latter he suggested for the first time might be achieved by designing superposed surfaces, as now usual in the biplane. The latter he suggested for the first time might be achieved by designing superposed surfaces, as now usual in the biplane. The wings he conceived should be supported by diagonal braces—which he termed "the great principle for producing strength without accumulating weight"—while he foreshadowed the necessity of streamline design in the maxim, that "in the art of aerial navigation every pound of direct resistance that is done away with will support 30 lb of additional weight without any additional power."

Henson's Steam Airplane

On the publication in 1843 of particulars of Henson's "steam carriage," he returned to the subject of mechanical flight and further explained his ideas on two letters to the *Mechanics' Magazine* in April, 1843. His criticism of Henson's scheme, though accompanied at the outset with an expression of encouragement, clearly indicated his reasoned doubts as to its success. In the first place "the magnitude of the proposed vehicle," involving a terrific stress on the necessarily light structure of the main supporting surfaces or wings— 150 ft. span and 30 ft. chord, as designed—afforded ground for serious misgivings. The stress or "leverage" on the wings Cayley again suggested might be overcome by securing the required surface not "in one plane, but in parallel planes one above the other," and he went so far as to propose a triplane, or "three-decker" as he termed it. Moreover, while expressing his conviction "that the inclined plane, with a horizontal propelling apparatus, is the true principle of aerial navigation by mechanical means," Cayley doubted Henson's ability to provide the "very great engine power—the *sine qua non* of the case"—which the design required.

As in the case of navigable balloons, Cayley's design for an "aerial carriage" (which he described in the same paper) is hardly as interesting, and certainly not as sound, as his examination and discussion of theoretical principles. His plan shows that instead of obtaining the required supporting surface by means of rigid horizontal wings, he proposed two sets of superposed circular planes (designed when in motion to act as helicopters) set at an obtuse angle, and revolving in contrary directions. These circular planes he termed "elevating fliers" to distinguish them from two smaller horizontal airscrews for propelling the machine. The "framing" or fuselage was to be covered with canvas at once to increase the surface and afford protection to the engine, while a "broad horizontal rudder or tail" was designed for use in ascent or descent, and to act as a stabilizing "elevator" in flight, with a small vertical rudder for lateral guidance.*

*Cayley's aeronautical writings as referred to in the foregoing are—
1 On Aerial Navigation (Mechanical Flight), contributed to Nicholson's *Journal of Philosophy*," Vol. XXIV., 1809, pp. 164-174. Vol. XXV., 1810, pp. 81-87 and p. 161, etc.
2 On Aerial Navigation (Dirigible Balloons), Tilloch's *"Philosophical Magazine"* Vol. XLVII. 1815, pp. 81-88 and 321-329, also Vol. L., 1817, pp. 27-35.
3 Practical Remarks on Aerial Navigation (Dirigible Balloons), 'The *Mechanics' Magazine*," Vol. XXVI., 1837, pp. 418-428, also (in the same publication) Retrospect of the Progress of Aerial Navigation, pp. 353-365 and On the Principles of Aerial Navigation, pp. 373-375; both in Vol. XXXVIII., 1843 and both dealing with Mechanical Flight.
4 Mémoire sur le Vol Artificiel (Wing-Propelled Gliding). *Bulletin de la Société Aérostatique et Météorologique de France*," No. 4, 1863, pp. 147-151.
The three papers in Nicholson's Journal (No. 1) were reprinted in the Aeronautical Society's Annual Report for 1875 and again as Aeronautical Classics, No. 1, 1910; also in Means Aeronautical Annual for 1909. The Practical Remarks (No. 3) were reprinted in *Aeronautics* Vol. II., 1908, p. 142, and Vol. III., 1910, p. 1.*

Aerial view of Logan Field, Dundalk, Md., the airport of Baltimore and home of the 104th Observation Squadron, Maryland National Guard

U. S. Naval Air Expedition into the Arctic

Airship Shenandoah and Naval Planes to Explore Vast Unknown Region of Polar Basin

With the approval of President Coolidge, the U S Navy has decided to send an expedition into the Arctic next summer for the exploration of a vast unknown region of the polar basin. White naval vessels will be used as auxiliaries, the expedition will be primarily aerial and include the rigid naval airship Shenandoah in addition to a number of planes.

When the expedition shall sail and the detailed plans have not been determined These are to be considered and investigated by a board appointed by Secretary Denby Rear Admiral Moffett, Chief of the Bureau of Naval Aeronautics, will be senior member of the board

This decision of the Government will not interfere with the arrangements recently completed with the Navy Department for Lieut. Ralph E Davison to take part in the transpolar flight by seaplane under the leadership of Capt Roald Amundsen. Three seaplanes will be used in the Amundsen flight and one of them is to be piloted by Lieutenant Davison. The Navy's expedition will be independent of the Amundsen expedition

The President's Letter

President Coolidge's letter of authorization to the Secretary of the Navy follows:—

THE WHITE HOUSE, Washington, Nov 20, 1923

My dear Mr Secretary

I desire to confirm by this letter the verbal authorization which I have already given you to proceed with the organization of a naval Arctic Expedition which will start in the coming year The record of the Army and Navy in this line of endeavor is one of which the American people will always be proud, for it is marked by a spirit of heroism and devotion which is unexcelled in the history of exploration. As it fell to the Navy to achieve the final goal, through the efforts of Admiral Peary, it is eminently fitting that the Navy should continue the work, and I believe that the expedition which you have in view will be of great practical value, and will be carried through with that thoroughness and efficiency which marks every project which the Navy undertakes.

Very truly yours,

CALVIN COOLIDGE

Secretary Denby's Order

Secretary Denby, in releasing this letter, also made public an order appointing Admiral Moffett senior member of the board to prepare plans for the expedition The order reads

"1 You are hereby appointed senior member of a board of which Comdr William R Furlong, U S N, Lt Comdr Ezra G Allen, U S N, Lt Comdr Fitzhugh Green, U S N, Lt. Comdr Robert A Bartlett, U S N R F, and Mr. Gilbert Grosvenor are members, and Lt Comdr Harold T Bartlett, U S N, is member and recorder, to convene at the Navy Department to make a thorough study of and to prepare a detailed plan for the exploration of the North Polar Region You will convene the board as soon as practicable

"2. The board will submit its report to the Department together with its recommendations in the premises.

"3 The members have been directed to report to you for this duty when informed by you as to the time the board will convene

"4 This is in addition to your present duties."

There are over 1,000,000 sq. mi of unexplored territory in the Arctic regions between the North Pole and Alaska, and as much as possible of this and other Polar territory will be explored An attempt will be made to discover whether or not the theory now held by scientists that a large continent exists in this region is correct Other valuable scientific data of practical value will be sought, and an investigation will be made of the feasibility of transpolar routes for aircraft flying east and west between Northern Europe and the Pacific

The expedition is said to be an outgrowth of the desire of Captain Bartlett, the explorer who sailed Admiral Peary's ship, the "Roosevelt," on the expedition of 1908-1909 which saw the Stars and Stripes raised over the North Pole again to make that journey Mr. Bartlett proposed to Secretary Denby some months ago that the Roosevelt, now in commercial service, be repurchased and equipped for Polar work.

Discussion of the possibilities of a new Polar expedition was immediately begun in the Navy Department It was pointed out by naval aircraft experts, however, that if a new "drifting" expedition were organized by the Navy, others, perhaps under another flag, might attempt and complete a journey to the Pole by air before the "Roosevelt" party could make half the distance The decision to employ naval aircraft followed

Captain Bartlett, who is a lieutenant-commander in the Naval Reserve Force, for the purposes of the Polar expedition, has already been called to active service in that rank and appointed to the special planning board, of which he will also be recorder

The Arctic board is, among other things, now at work on discussing the possible line of flight for the Shenandoah One would lead direct from Lakehurst to the Polar regions and return The other contemplates the establishment of a base in the Alaskan peninsula. The latter route was favored It is some 3,000 mi from Lakehurst to the Pole, and 6 000 mi would have to be covered in a non-stop round-trip voyage

On the other hand, with Nome, in Alaska, as a base, the distance to the Pole and return would be much less, and that line of flight contains other elements which appeal strongly to members of the board

Officers of the naval air station at Lakehurst are delighted at the prospect of the Shenandoah being used in the Navy expedition. Comdr J H Klein, Jr, executive officer at the station, and Comdr R D Weaverbacher, designer of the Shenandoah, expressed the confidence of the officers that the airship would be able to complete the trip successfully

According to Commander Klein, mooring masts similar to the mast near the Lakehurst hangar probably will be constructed at four or five strategic points along part of the line of flight. This would give the Shenandoah anchoring facilities equal in safety to those at Lakehurst. He said that such masts could be built in two months.

Hakon H Hammer, an associate of Captain Amundsen, announced that the Amundsen transpolar flight from Spitsbergen to Alaska over the North Pole next summer plans to carry a limited quantity of mail in its three airplanes. The mail will consist of light-weight post cards bearing a specially designed transpolar stamp

Air Mail Across the Pole

That the Arctic offers interesting possibilities to air navigation between America and Europe has recently been voiced by Vilhjalmur Stefansson, the noted Arctic explorer, as our readers may recall.

According to him, the proposed Navy expedition into the Arctic should tend to the development of regular transpolar airship mail routes within ten years and eventually should result in continuous air commerce over the North Pole during every month of the year

Mr Stefansson predicted that the polar sea, in that would be covered with a network of air lines like the network of steamship lines covering the Atlantic, and that the supposed terrors of the Arctic would disappear Instead of being a barrier between America and Asia the Arctic, he predicted, would become a highway of trade. The whole problem of world transportation would be changed almost as much by this idea, he said, as it was by the idea that the world was round instead of flat.

"If the Navy plan were a mere attempt to reach the North Pole it would have little interest or value," said Mr. Stefansson. "If it is looked upon as a new Polar expedition to explore the regions never before visited by any explorer and to carry ahead the work previously done by other explorers, then it becomes an event of great interest and importance

An Event of Great Importance

"If Admiral Moffett's plan is developed along the lines he originally indicated, then, and then only, will it be an epoch-making event. Admiral Moffett has said that he looked upon a crossing of the Arctic Ocean from Alaska to Europe or from Europe to Alaska as a voyage indicating an era of transpolar commerce by air He has said, and I think that most authorities agree with him, that flying in the Arctic summer probably is no more dangerous or difficult than a flight of the same length over Brazil or between New York and Europe. If the voyage in the Shenandoah demonstrates what we expect then, as Admiral Moffett has said, we shall have regular transpolar dirigible mail routes within ten years.

"In all probability, the first regular route would be between London and Tokio, because these are important cities between which there is a steady interchange of urgent letters and dispatches That route would be several thousand miles shorter than an air route following roughly the Trans-Siberian Railway We believe that the northern route (north from England past the north cape of Norway, then across Nova Zembla and south across Eastern Siberia) would have various advantages over any other route, besides the shortness, and that it would not be many years from the inception of midsummer transpolar mail service until the service would be continuous throughout the twelve months. Some authorities go so far as to say that mid-winter probably would be the most favorable time of year.

Polar Temperatures

"According to the works of theoretical meteorology, published as much as ten years ago, the average temperature in July at the North Pole itself, five feet above sea level, was estimated at exactly the freezing point. It is now believed that the average temperature of July, 1,000 ft above the sea, would be from ten to twenty degrees warmer, or between +40 and +50 deg. F In January the temperature at flying heights might average as low as 40 or even 50 deg. below zero, but that would be no colder than the air at similar heights over certain parts of the Northern United States, and not nearly so cold as that encountered by planes flying at such great altitudes as might be required under certain war conditions—above France, for instance

"Summer fogs in the Arctic, although common, are on the average much lower than fogs further south, and flying would be largely above them. The reason why some of the authorities believe winter would be the best flying time in the Arctic is that clouds are then almost as rare as over the Sahara Desert

Arctic Air Commerce

"What principally interests me about the Arctic is not the reaching of those places that are still unattained, but rather the increase and diffusion of our knowledge about the polar regions If, as Admiral Moffett's previous announcements have foretold, this turns out to be the beginning of a transarctic air commerce that eventually shall cover the polar sea with a network similar to the network of steamship lines that now cover the Atlantic, then in my opinion will the polar regions, we have believed in practically disappear. For we shall find that most of their terrors have been greatly exaggerated and most of their advantages and charms have been minimized or hidden.

"The Arctic is the smallest of all the oceans. If you look at a map of the Northern Hemisphere (one that has the equator for a circumference) you will see that the Arctic lies between North America and Asia somewhat as the Mediterranean lies between Europe and Africa."

New Attempt at Altitude Record

Lieut. John A. Macready, A.S., will soon make an attempt to establish a new altitude record. The main purpose of the flight is to thoroughly test a new and improved supercharger invented by Dr. S. A. Moss, to enable an aviation engine to function at sea level efficiency in the rarefied atmosphere of high altitudes.

On Sept 28, 1921, Lieutenant Macready established the world's record at 34,509.5 ft. This remained the record until Oct. 30, 1923, when Sadi Lecomte, the French flier, ascended to an altitude of 36,564 ft. This is the record which, in connection with the supercharger test, Lieutenant Macready aspires to brat.

The supercharger to be tested has undergone considerable refinement in design over the one used by Lieutenant Macready when be established the record of two years ago. In addition to improving the cooling and fuel systems the speed of the turbine wheel has been increased from 22,000 to 34,000 r p m To secure this result the turbine and shaft were machined from a solid block of forged steel weighing 250 lb., though the finished product weighs only 8 lb At 35,000 ft altitude it will increase the power of the Liberty engine by over 300 hp A commercial compressor delivering the same amount of air as this supercharger would weigh 5,000 lb. and occupy a space of 288 cu. ft.

Lieutenant Macready will use the old Lepère (P53) plane which on three previous occasions has been used in the establishment of altitude records To make the test less gruelling for the pilot, new systems have been devised for heating the cockpit and supplying oxygen It is planned to use liquid instead of gaseous oxygen This fact that the liquid oxygen is tasteless, will add to the comfort of the pilot, while its complete dryness precludes the clogging of the supply pipes by ice formed by the intense cold of the enormous altitude

Strange vagaries of the human mind are developed during these flights at great heights, according to a War Department release For instance, there seems to be a general tendency to read backward the figures on control instruments. Some of these are probably due to the difference in the air pressure from that to which man is accustomed, some are due to the lack of oxygen which can not be entirely replaced by artificial means, some no doubt to the intense concentration necessary to keep the plane climbing by securing the proper functioning of the engine while the pilot's endurance is gradually ebbing.

Flying in Wyoming

Editor, AVIATION:—

I have read with interest in your issue of Nov 26, the experience of Lloyd M Long, while flying in the wild state of Texas. It appears that he had some difficulty in getting his ship and the weather to declare an armistice In fact I believe he intimates that the usual condition of the atmosphere had overstepped the accepted treaties of nature, and were far from tranquil—so much so that at times the lift-drift ratio of his particular ship absolutely refused to function

May I venture to voice, what all the people of this neck of the woods knows, namely that Mr Long "aint been nowhere, nor seen nothin." An invitation is hereby extended to him to bring his ship and visit that part of the world called Wyoming, and I will endeavor to entertain him on certain days when not only his ship but an Air Mail DH with a 400 hp motor wide open will fall precipitately 3000 ft., in which time Mr Einstein could not find any lift in the RAF 15 wings with the Theory of Relativity. At another time and place I will endeavor to show Mr Long that a 4000 lb ship will rise to 14,000 ft above sea level at the rate of 2500 ft per minute which is even greater than the manufacturers claim

Please extend this invitation not only to Mr Long but to any other brothers in flying who may not have had the pleasure (?) of flying out here, where weather is synonymous with cussing, and if any prefer we can take a night flight where there will be no autos, nor roads nor even a house for 50 mi. or so

HARRY A. CHANDLER
Air Mail Pilot
Rock Springs, Wyo Nov 30, 1923

AIRPORTS AND AIRWAYS

St. Louis News

By Manuel Hahn

Spotty weather, while keeping heavier-than-air flying down, has not interfered much with activities at Scott Field, the Army's lighter-than-air station at Belleville, near St Louis. The TC3, sister ship of the big airship that burned at Wright Field last summer while on a visit there, has just returned to its home hangar at Scott Field after a two week's stay. It originally went for two days only, but the return was delayed, first to take part in a new circus arranged at San Antonio, and secondly by bad weather at the southern metropolis. With the inflation of the AC1, cabin cruiser airship, with helium, all of the airships at Scott Field are now non-explosive. The free balloons and Caquot kite balloons are still hydrogen filled, and will remain so.

The airway from San Antonio to Belleville is now in working order. The Martin Bomber of the Airways Section, which is making a trip back from the Western coast, stopped in at Lambert-St Louis Field last week. This field may be made the airways station of St. Louis, as it is more easily accessible.

The Flying Club of St Louis has financed a club house, to be erected at the field. The very modest building will be built by private subscription, a canvass of the members yielding over $1000 for the purpose.

The annual election of officers of the Flying Club of St. Louis put John S Powell in the president's chair, vice Randall Foster, who has occupied that position since the founding of the club. Foster was elected to the Board of Directors. Preston Sulton was elected vice-president.

Purchase of a ship by the 110th Air Squadron, National Guard, has marked the start of flying activities by this unit. The overhauled Jenny has spent more hours aloft every day flying is possible than she put in a wash before. All of the officers of the squadron are qualified pilots, and are regaining their "air-legs" rapidly, under the tutelage of Maj. Wilham Robertson and Lieut Frank Robertson. These two pilots had two interesting rides early last month. A telephone call at midnight, the day Gov Jack Walton of Oklahoma was impeached, brought Wilham Robertson to the field at daybreak, to meet one of Walton's attorneys, with two associates. All three of them were carried to Tulsa in less than 5 hrs flying time. The same week, a call from a citizen, who had a telegram calling him to his brother's death bed, brought an early morning start for Des Moines. Frank Robertson, who piloted, was forced down by rain, took a fresh start after the rain dwindled, but was finally forced to land 50 mi from the Iowa capital, in another rainstorm.

The newly formed Naval Reserve Air Unit has rented the use of the Flying Club ship part of each week, and is training six cadets regularly.

Chicago News

By Otto Klein

The South Park playgrounds, where boys are taught to make model airplanes, held one of their inter-park tournaments Tuesday, Nov 27. There are now six playgrounds in the South Park system that have model clubs, Mark White square and Cornell square having some thirty members each. At Tuesday's meet the Mark White boys, who issued the invitations, carried off all honors. The longest flight made by a power model was 47 sec., which is very good considering the fact that the boys, most of whom are only twelve years old, only began model building last spring without any previous experience whatever. Most of the boys have not even had a close look at a real airplane.

Among the various events was a model glider contest in which the best machine, launched from a stage, glided 50 ft. The boys will continue their glider experiments and when their experience permits they will construct a real glider of the sampler type. The instructors also show the boys many other experiments which tend to hold their interest in the work. The boys have, for instance, read about Captain Richenbacher flying with one propeller blade shot away. To prove the possibility of this they equipped a model with half a propeller and found that it could be made to hold altitude. During the evening of the coolest Florence Macbeth, the opera star, whose husband was a member of the R.F.C. and who donated a cup at last summer's model meet, spoke to the boys and encouraged them in their work. Much credit is due the South Park officials for providing such interesting and educational entertainment for the boys at their playgrounds.

"Andy" Anderson, who has accompanied Nimmo Pack on many long trips, but who has only recently received flying instructions, has soloed at Ashburn field.

J. A. Yonge of the Great Lakes Aviation Co. is flying in the vicinity of Fort Wayne, Ind., on photographic work. The company was one of the first to buy one of the new Lincoln-Standard semi-cabin planes. For the time being they are making their headquarters at Ashburn field, but may later open a field of their own. It was the ship of this company in which the marriage ceremony was performed at the Dixon air meet recently.

Private Aircraft on Army Fields

Civilian pilots will be interested in the following order, issued Nov. 14 by the War Department —

"It is the policy of the War Department that owners of private aircraft should not be permitted to use any active Government airdrome as a base. The use of such airdromes by operators of private aircraft may, however, be permitted, in the discretion of the commanding officer of the station, upon condition that the aircraft is not operated for profit, that it is housed in privately owned hangars not located on Government land, and that assistance will not be required from the personnel of the station as to maintenance, repair, or operation.

"In the case of Government-owned airdromes announced from time to time as being on an inactive status, operators of private and commercial aircraft may be permitted, when airdrome facilities are available, to use such facilities, subject, however, in each case to the approval of the War Department and under such regulations as are now or may hereafter be prescribed.

"With regard to airdromes leased by the Government, owners of private and commercial aircraft may obtain permits from the lessor to use the facilities at such airdromes under the rules and regulations that apply to the use of the airdromes by Army organizations. In all cases, however, this permit must have the approval of the War Department.

"Operators of aircraft making use of the facilities at any Air Service airdrome will be required to conform to the local rules and regulations in force at that station."

The Records We Hold

The United States today holds thirty-five out of forty-two aviation records of the world. actually she only holds thirty-three, but with the records made at Cowse and Mitchell field, which will doubtless be homologated, she gains two more making the thirty-five. Of these the Navy holds twenty-three and the Army twelve.

The remaining seven records are shared as follows: France 3, England 2, and Italy and Spain 1 each.

New Seaplane Record

An attempt to surpass the seaplane altitude record held by Lieut C. F. Harper, U. S. Navy flier, was made by the French aviator Laporte in an F.B.A. flying boat, on Nov. 13. Laporte's barograph indicated a height of 4630 m. This figure has not as yet been officially passed upon.

For Air Navigators

It is recalled to the attention of air navigators and pilots in general that both the Army and the Navy periodically publish current information regarding airways, landing facilities and flying directions for aircraft.

The Airways Section of the Army Air Service publishes for this purpose the "Aeronautical Bulletin," each issue of which contains either a detailed description of a permanent airport, with the necessary outline and location maps, or complete flying directions covering a route between two airports (both ways). Some seventy issues of the "Aeronautical Bulletin" have appeared so far, and others are in preparation. Copies of this publication may be procured at 5 cents per copy from the Superintendent of Documents, Government Printing Office, Washington, D. C.

The important information service is supplemented by the Hydrographic Office, Navy Department, by a monthly publication called "Notice to Aviators" in which current information of landing facilities, with special regard to sea aircraft, warnings, etc. is made public. The Hydrographic Office requests, just as the Airways Section, the earnest cooperation of all flying men to make this publication effective by forwarding to the Hydrographic Office any information of use to airmen.

Those cooperating in this work will, upon their request, be placed on the mailing list of the Notices to Aviators and receive them free of charge.

Following are the contents of the Notices to Aviators for the last four months:—

September, 1923—(15) Airports at Higham Harbor, Boston, Mass. (16) Seaplane facilities at ports of call between Hampton Roads, Va., and Panama.

October, 1923—(17) Seaplane facilities at ports of call between Hampton Reads, Panama and Guantánamo Bay, Cuba. (18) Seaplane facilities at ports of call on West coast of Costa Rica, Central America.

November, 1923—(19) Boston airport (farther facilities). (20) Landing field at naval air station, Lakehurst, N. J. (21) Seaplane facilities between Hampton Roads, Panama and Guantánamo Bay, (Cuba) (continued).

December, 1923—(22) Seaplane facilities on the coast of North Carolina. (23) Seaplane facilities at Georgetown, S. C. (24) and (25) Seaplane facilities on West coast of Florida. (26) Facilities for seaplanes on route from Pensacola, Fla., to Hannibal, Mo. (27) Seaplane facilities on East coast of Yucatan, Mexico. (28) Seaplane facilities on coast of British Honduras. (29) Seaplane facilities on East coast of Nicaragua. (30) Landing fields in the vicinity of Los Angeles, Calif. (Arcadia, Glendale, Long Beach, Los Angeles, Santa Monica and Wilmington). (31) Flying conditions at Tutuila, Samoa South Pacific Ocean. (Conditions are adverse at Pago Pago Harbor owing to violent gusts.)

The attention of pilots is also called to the excellent Pilot's Directions for the New York-San Francisco Route, compiled by the Air Mail Service and published by the Government Printing Office in 1921. It is not known whether this valuable publication is for sale or whether it is otherwise procurable. If it should be out of print, it is suggested that it be reprinted in the handy size adopted by the Airways Section of the Army Air Service for its Aeronautical Bulletin.

Peoria (Ill.) News

This has been a busy year for the Varney Aircraft Co. At the close of last year's winter flying class in February the company opened its spring class with many students in attendance from various parts of the United States and Canada. One of the students, Walter Traschler, came from Switzerland. He learned rapidly and is now a very good flier. He expects to return to his native land and start a flying business there. The efforts of the employment service in securing positions for graduates of the school was more successful than had been anticipated.

Last Memorial Day a very successful air meet was held, including races, parachute jumps, and formation flying. The main event was the bombing from the air of a small village. Around it nearly 15,000 persons watched the demonstration, but as most of them lined the highways surrounding the field, the meet financially was unsuccessful, though it did prove a very good venture, as following the meet the passenger and aerial-taxi business increased very rapidly. Shortly after this, however, occurred the only fatality which ever marred aviation in Peoria and vicinity. Clarence Brown, an experienced flier, especially noted for his stunt work, one of the first students trained at the Varney school, was the victim. Returning from a cross-country flight, he began, as was his custom, to do a few stunts before landing. Instead of coming out of a dive following a wing-over the machine assumed an upsidedown position, and fell to the ground in this position. Upon examination of the wreckage the pilot's control stick was found missing. Several days later it was found partially buried in the earth, nearly a quarter of a mile from the wreck. Undoubtedly the control-stick came out while the ship was on its back, leaving the unfortunate flier little means of control.

Although Mr. Brown was in an way connected with the company, being an itinerant flier, the business naturally suffered tremendously as the result of this accident which received widespread publicity from the newspapers, locally. This is only one more incident where a splendid young flier would be alive today, and the aeronautical industry would have been saved much advese publicity, if we had proper legislation regulating flying. However, interest in flying is picking up again, as public confidence is gradually being restored and next year will no doubt witness a great deal of flying in Peoria and vicinity.

The company is now making preparations for a large winter class for it was found last winter that a flying class could be held during the winter months with great success. With the motors properly protected from the cold, and with the instructor and students dressed in warm flying suits, little discomfort is suffered from the cold, especially as the winters at Peoria are rather mild.

Photo Flying Boat Returns

A special flying boat equipped for aerial photography by the Fairchild Aerial Camera Corp. finished a very successful flying trip in Canada by covering 550 mi. from Grande Mère, Province of Quebec, Canada to Port Washington, L. I. in 6 hr. This machine was used by the Fairchild Aerial Surveys Co. (Canada) Ltd. The start on the return flight was made from Grande Mère at 10 a. m. and the party arrived at Port Washington at 4.30 p. m. Only one landing was made en route, at Lake George, where a fresh supply of gasoline was taken on board. Pilot K. F. Saunders and Mechanic C. Kahre expressed complete satisfaction with this boat—a Curtiss—and stated that they had experienced no serious troubles during the entire photographic flight.

Many times, according to Saunders, the flights were over heavily wooded country where an water was available for effecting a landing and where the two men and the photographer depended entirely on the motor to get them to their destination. The maps they were using were very inaccurate and in a great deal of their flying they had to depend entirely upon a compass. On account of the fact that they were over desolate and wild country, no flight was commenced without an ample supply of emergency rations being aboard.

Proposed Air Line France-Near East

A large French concern proposes to establish an aerial transport line between France and Greece, in connection with the opening of a service between Marseille, Pirnens, Constantinople, and the Black Sea, and between Marseilles, Piraeus, and Alexandretta, Syria. The proposition is being considered by the Greek ministry of communications.

According to the Hon. Aldo Finzi, Italian vice-commissioner for aeronautics, this service will be run in conjunction with an Italian air transport company. Seaplanes will be used between Marseille, Ajaccio and Rome, landplanes from Rome to Brindisi, and seaplanes from Brindisi to the Near East.

W. C. Young Married

W. C. Young, manager of aeronautic and government sales, Goodyear Tire & Rubber Co. was recently married to Miss Hazel Veltum, formerly of Louisiana, Mo., at the residence of Mr. and Mrs. W. B. Elgin, 518 Ft. Washington av., New York City. The Rev. Walter Rohlen officiated.

U. S. ARMY AND NAVY AIR FORCES

Status of Organized Reserves

The following is quoted from the annual report of Gen. John J Pershing, General of the Armies and Chief of Staff, to the Secretary of War —

"Among the most important considerations in developing an effective system for National Defense, are the establishment of a sound system for exploiting our resources to provide for the current supply of our war armies, the maintenance of a reserve stock of the vital items of war material and equipment sufficient to meet the initial mobilization requirements, and the creation in time of peace of a corps of officers to instruct our men and to lead them in battle

"The provision of suitably qualified officers for the Regular Army and the National Guard is a clearly defined problem, since the numbers involved are relatively small and the development of the individuals progresses automatically through service with their respective organizations. The majority of our war-time officers, however, must be found in the Officers' Reserve Corps, which supplies the leaders for the skeleton units of the Organized Reserves, whose ranks will be filled by the great mass of citizen soldiery in time of National peril As the reserve units under our military policy are inactive in time of peace, the recruiting and training of their officer personnel presents a difficult problem

"The spirit exhibited by the reserve officers in enrolling and in endeavoring to fit themselves for their duties has been admirable Most of these men served the country in the World War and today occupy positions of responsibility in the various walks of life. With few exceptions, they all have exhibited a willingness to make the personal sacrifice necessary in order to obtain a basic military education.

"We believe that each reserve officer should attend a summer camp or serve with an organization of the Regular Army at least once in three or four years, but at the present rate we are able to give annual training to but one in ten. Furthermore, those who receive this training suffer an actual financial loss because the mileage allowances are not sufficient to cover the cost of travel

"At the present time there are approximately 77,000 reserve officers, of whom some 50,000 are war veterans The latter number will decrease rapidly until the personnel of the Officers' Reserve Corps must be composed entirely of men who have accepted the obligation of military service since 1919. To provide the annual replacements for the veteran officers at least 7,000 Second Lieutenants must be commissioned in the Reserve Corps each year This year we are commissioning about half that number To meet this situation the R O T C must be further encouraged and an additional number of young men should be trained yearly in the summer camps.

"It is the purpose of our military policy to create a force as a first line of defense consisting of the Regular Army and the National Guard, ready to take the field immediately upon the outbreak of war and protect our frontiers until the man power of the nation can be mobilized in the Organized Reserves At best, the former force would be insufficient to do more than hold the line temporarily On the other hand, without the protection of this force, the Organized Reserves would themselves be helpless against even a weak attack

"In July 1921, this first line force had a strength within the continental limits of the United States of 168,000 Regulars and 114,000 in the National Guard At the present time there are 92,000 Regulars and 160,000 National Guardsmen, or a decrease in the total force of 30,000 We cannot contemplate a further reduction On the contrary, it is the conservative belief of the War Department that the National Guard should be given the support necessary to raise it to an efficient force of 250,000 men, and that the Regular Army should have a minimum of strength at 150,000 enlisted men and 13,000 officers.

"We have made progress in the organization of the framework for a great citizen Army to maintain the honor and prestige of America in the event of a national emergency, but the total number of individuals under military supervision has decreased by 15,000 during the past three years. This decline presents a serious problem which should receive thoughtful consideration from every responsible citizen. Are we making real progress toward the modest goal which we have set for ourselves, or are we falling back into the unprepared condition which has heretofore existed in this country? I sincerely hope that it is the will of the American people that we should carry out a conservative and balanced program for the National Defense in preparation for whatever emergency we may be destined to encounter"

France Field Breaks Pistol Record

Competing against the entire United States Army for the 1923 annual pistol qualification honors, Air Service troops at France Field, Canal Zone, have attained percentages heretofore believed impossible by the best gun cranks, using the regulation 45 pistols. Ninety-two and a half per cent of the entire command at the field qualified over the Regular Army course.

The 12th Photographic Section, commanded by 1st Lt. L. W. Miller, and the 40th Intelligence Section, commanded by 1st Lt. John M. Clark, each qualified 100 per cent of their commands, while Group Headquarters has only two men who failed to qualify.

Maj. Follett Bradley, the post commander, fired with Group Headquarters, making a score of 411 or 91.5 per cent. Major Bradley has taken part in several national and international meets with the Navy teams at Camp Perry, Ohio, prior to his arrival in the Canal Zone.

The 63d Service Squadron, commanded by Capt Harrison Fhekinger, and the 7th Observation Squadron, commanded by Capt. O. H. Quinn, ran neck and neck for third place. The 7th Squadron had 154 men to fire the course and only sixteen unqualified, which gave this organization 90 per cent in qualification, while the 63d Squadron had 182 to fire the course with only eighteen unqualified, thus giving a percentage of 90.6 to the 63d Squadron, while in the 25th Bombardment Squadron every commissioned officer attained the grade of expert. This organization is commanded by Capt. Harry M. Smith.

Border to Border Refueling Flight

Eating breakfast on the Canadian border and dropping down to Mexico for an early supper is the distinction achieved in a remarkable flight made Oct. 25 by Lieuts. Lowell H. Smith and John P. Richter, in the DH4B Special, which was used by them in breaking the endurance record on Aug 27 and 28 of this year

The border to boeder trip was started at Sumas on the Canadian-Washington border at 6 27 a. m. Oct. 25, and contact was made by Lieuts Virgil Hine and F. W. Seifert above Eugene, Ore, at 10:05 a. m, when 50 gal. of gasoline were given the racing plane in less than a minute. A few minutes later another contact was made and 25 gal more of the fuel were emptied into the emergency tank, Lieutenants Hine and Seifert returning to Eugene, preparatory to leaving for Crissy Field. Thirty-five hundred feet over Sacramento they took aboard 75 gal of gasoline from the refueling plane piloted by Capt R. G. Ervin, assisted by Lt. O R McNeel, who, after completing this task, returned to Mather Field.

Lieutenants Smith and Richter continued their south-bound journey without incident and circled over the Customs House at the Tia Juana line at 6-42-40 p m, completing the 1280 mi trip in 12 hr 13 min 40 sec. Approximately 275 gal. of gasoline were used by the Liberty 12A during the trip

The border to border non-stop flight was conceived and executed by the personnel at Rockwell Field, and in the face of a great many obstacles Some slight improvements were made on their former method of refueling, and the big project was successfully carried through to completion

Personnel of Central American Flight

The Air Service officers assigned as members of the Central American Flight, with assignment of duties, are as follows.

Maj Ruycroft Walsh, flight commander: Correspondence, diplomatic contact, coordination

Maj Follett Bradley, assistant flight commander: Airways report

First Lieut. Perry Wainer, flight communication officer: Flight log and history.

First Lieut. L. W Miller, flight photographic officer: Publicity.

First Lieut. F. P Albrook, flight engineering officer: Preparation of material, spare parts and supplies

First Lieut Levi L Beery, flight navigation officer: Personal equipment.

First Lieut John M Clark, advance agent.

Lieutenant Clark has already departed on a trip over the contemplated itinerary of the flight to make detailed arrangements for handling supplies, preparing landing fields, obtaining governmental cooperation in the various countries, etc.

His itinerary will take him from France Field to Port Limon, Costa Rica; San Jose, C. R.; Pontarenas, C. R, Corinto, Nic., Managua, Nic.; Amapala, Hon, Tegucigalpa, Hon Comayagua, Hon., San Pedro Sula, Hon, Puerto Cortes Hon, Puerto Barrios, Guat., Guatemala City, Goat.; San Salvador, Salv., Acajutla, Salv.; and then back to France Field. The trip will be made by boat, rail, auto and donkey.

Three airplanes will comprise the Central American flight, probably a Martin Bomber and two DeHaviland planes. The DH4B planes will be used for all missions in connection with airways charting, whereas the Martin Bomber will transport three enlisted mechanics and will carry such radio equipment as may be needed to maintain communication between the DH4B planes while out on airways charting missions

Refuelling in Air not without Denger

The Army Relief Fond Air Carnival at Kelly Field on Nov 18 was saddened when Lieut Paul T Wagner, giving a midair refueling exhibition, crashed and was fatally injured The accident happened when Lieutenant Wagner's plane, carrying the fuel, lost altitude, causing the hose to slacken and in some way to entangle the right wings of both planes. The right wing of the upper plane was torn off, and Wagner crashed to the ground He was hurried to Kelly Field Hospital, where he died during the night Lieut Walter R Peck, piloting the plane to be refueled, landed safely

Cadet Sigma Gilkey, advanced flying school student, was also slightly injured, when in an endeavor to avoid a collision the nose of his plane was driven into the ground

Lieutenant Wagner was born Sept 3, 1923, in Oregon He enlisted in the Aviation Section, Signal Corps, April 13, 1908, was appointed Second Lieutenant on Oct. 30, 1908, and promoted to First Lieutenant July 1, 1920.

He was on duty at Mather Field, Calif, from Oct 30, 1918 to Nov 15, 1918, at Post Field, Fort Sill, Okla., to June 27, 1922; on leave to Oct. 4, 1922; on duty at Kelly Field, Tex, to date of death

Fliers Hurt on Way from Air Meet

Advice has been received from Buffalo that Lieut Frank Hunter, A.S. and Capt Burt Skeel, A.S. who stunted daringly at the Mitchel Field aerial carnival on Election Day, were injured when forced by a dense fog to land in their MB3 pursuit planes near Chaffee, 35 mi from Buffalo, on Nov. 12. Lieutenant Hunter, who has an outstanding war record as an ace, was badly cut in the forehead and otherwise seriously injured Captain Skeel's injuries were said to be minor. Both fliers received first aid treatment at Holland, N. Y., after which they were hurried to a Buffalo hospital The officers were flying to their home station at Selfridge Field, following their participation in the Mitchel Field meet.

Wilber Fagley Field on Transcontinental Route

Wilber Fagley Field, Kokomo, Ind., a modern flying field, with its giant white cross and circle beckoning the itinerant airman to 100 acres of safety, has been placed on the transcontinental route, on the branch from Detroit to San Francisco by way of St. Louis, through the recommendation of Maj. Gen. Mason M. Patrick, Chief of Air Service.

The Kokomo Field has for some time been on the Model Airway, being the intermediate stop between Chanute and Selfridge fields on that route.

U. S. NAVAL AVIATION

Movements of Aircraft Ships

The U S S Langley, the Navy's experimental aircraft carrier, will be assigned to the Aircraft Squadrons Battle Fleet, on the West Coast, some time next summer. The Langley will go from the Naval Air Station at Pensacola to join the Fleet in southern waters for the winter maneuvers for a short time, but will return to Pensacola to carry on experimental work there, which it is expected will be completed some time in June

The U S S. Aroostook, attached to the Aircraft Squadrons Battle Fleet, is now at the Navy Yard at San Francisco undergoing overhaul preparatory to going South with the planes for the winter maneuvers.

The U S S. Wright, attached to the Aircraft Squadrons Scouting Fleet, on the Atlantic Coast, will also be present with the planes and the Fleet during the winter maneuvers. These maneuvers will engage the attention of the Aircraft Squadrons during the winter and the greater part of the spring

Personals

The Navy Department announces that the following named enlisted men were instantly killed on Dec. 3, 1923, in collision in air between a JN4 and a VE7 at San Diego, Calif —

Entwistle, Thomas Ellsworth, Aviation Chief machinist Mate, U S N. Next of kin, wife, Mildred A. Entwistle, 3 Cave Lane, Pensacola, Fla; and

Jackson, Willard Benjamin, Chief Machinists Mate, U S Navy. Next of kin, wife, Grace Myrtle Jackson, 4095 Swift Ave., E San Diego, Calif

Lt Col T C. Turner, U S M C., chief of the Marine Aeronautical Section of the Navy has been appointed Aide to Secretary of the Navy Denby

Quantico Marine Fliers Busy

The Marine Flying Field at Quantico, Va., is the scene of much activity as the station prepares for the coming maneuvers with the Fleet in southern waters this winter. The DT planes on the station are undergoing changes to fit them for the maneuvers and the officers and men of the station are attending school, to familiarize themselves with the problems that will be presented during the maneuvers. The officers are taking up radio and spotting, and the enlisted men gunnery, bombing and radio

Pensacola Testing New Training Planes

Three of the new types of training planes are being flown daily at the Naval Air Station at Pensacola, namely, the Martin training plane, the Boeing training plane and the N2N, constructed at the Naval Aircraft Factory

Three of the last named planes have been received from the Naval Aircraft Factory, one of them having been set up and flown The HN2, made by the Huff Daland Co, is undergoing changes in the engine bed, and will be flown soon

Aircraft Squadrons Battle Fleet Reviewed

A visit was made Nov 17 to the Aircraft Squadrons Battle Fleet, stationed at the Naval Air Station at San Diego by Vice Admiral S. S. Robison, Commander in Chief, Battle Fleet. An aerial review and exhibition was held in his honor, planes from the Aircraft Squadrons participating There were DH4B planes from VO Squadron Two and TS1 planes from VF Squadron One in the review, which consisted of aerial maneuvers and formation flights.

Naval Officers Selected for Flight Training

The officers listed below have been selected by the Navy Department to take aviation training at the Naval Air Station at Pensacola, Fla., and will comprise the next officers' training class that will be started at that station. The officers will accompany the Fleets in January to the Caribbean when the units of the Navy assemble for winter maneuvers. From there the officers will be sent to the Naval Air Station at Pensacola at the earliest practicable date.

The officers selected are the following: Lieuts. M. R. Browning, M. B. Stonestreet, C. T. Gladdan; Lieuts. (j-g) E. S. Stoker, R. D. Hill, A. D. Blackledge, C. C. Ferrenz, A. L. Mann, F. L. Baker, G. A. Patterson, M. F. Sproul, Max. Welborn, S. H. Arthur, K. H. Robey, R. W. Signer, W. L. Eaghton, H. C. Bebner, F. R. Buse, J. P. Graff, I. M. Hansen, A. T. Lamore, G. A. Seitz, L. C. Stevens, J. F. Crown, J. H. Gowan, C. T. Gladden; Ens. F. O. Kahn, S. B. Moore, W. H. Beyrer, B. Settle, F. D. A. Ford, C. S. Alexander, L. D. Pace, L. H. Pollard, C. R. Brown, E. C. Ewen.

Besides the above listed officers, thirty-four additional officers have been selected for flight training at Pensacola, provided that they pass the necessary physical examination, for aviation duty. The officers who are thus qualified will be notified at a later date.

Orders to Officers

Lt. Comdr. Zachary Lansdowne, previous orders 9-6-23 to Naval Air Station, Lakehurst, N. J., revoked. Upon completion temp. duty Nav. Intelligence det. to Bureau of Aeronautics, Washington, D. C.

Lt. James R. Kyle, det. U.S.S. Langley, to Nav. Air Sta. Hampton Roads, Va.

Lt. George D. Price, det. Aircraft Squads., Scouting Fleet, to Bureau of Aeronautics, Washington, D. C.

Lt. Spencer H. Warner, det. Nav. Air Sta., Pensacola, Fla., to Naval Air Station, Anacostia, D. C.

Lt. (j-g) Lloyd K. Cleveland, orders 11-17-23 modified, carry out remaining orders assigning U.S.S. Chewink.

Phar. Hugh C. Beal, det. U.S.S. Aroostook, to Nav. Hosp. Mare Is., Cal.

Phar. John H. Reed, det. Nav. Air Sta. Hampton Roads, to Nav. Hosp. Norfolk.

New Engine Overhaul System

A new inspection system for engines has been introduced at the Naval Air Station at San Diego, Calif. Formerly each squad in the engine overhaul shops was given an engine to disassemble, overhaul and assemble. Under the new system the engines are disassembled and washed by a permanent crew. The broken down engine is then sent to the chief inspector, who decides what parts are no longer serviceable. The latter replaces these unserviceable parts, making entries in the log book, and sends the engine to a squad for assembly. Meanwhile the smaller jobs, such as grinding valves, testing pumps, etc., are sent out to special squads who specialize in this work. It is hoped that the quality and quantity of production will be increased by this new system.

Pensacola Planes at Mississippi Fair

Six landplanes from the Naval Air Station at Pensacola, Fla., attended Jackson County Fair, at Pascagoula, Miss., on Nov. 20. The flight was composed of three JN4H's, two DH4B's and one VE9 and was made for a threefold purpose, namely, to give cross country flying practice to the personnel, to give Navy representation at the dedication of the Pascagoula Municipal landing field, and to add to the interest of the fair. The municipal landing field is an excellent four-way field and is an important addition to the flying facilities in the Gulf States. The planes returned to the station on Nov. 23, and reported that the flight was very successful in every way.

Fast Trip from New York to Norfolk

A very fast trip was made from New York to Norfolk by a VE9 plane of the Naval Air Station at Hampton Roads on Nov. 25. The plane, with Lieutenant Wooster and Lieutenant (j-g) Tate, made the trip in 2 hr. 30 min. flying time or at a rate of about 136 mi./hr.

INDEX TO ADVERTISERS

Aircraft Magazine Files For Sale

The following list of back numbers of aircraft papers is available to anyone wishing to secure aeronautical information covering the past few years, both in the United States and abroad. These copies are in unbound form but many have been prepared for binding by removing advertising pages. The original price of the issues ranges from ten cents to fifty cents.

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L'Aerophile, (French) 1921, 6 issues, 1922, 7 issues.
Flying, (English) 1919 18 issues.
Aeroplane (English) 1916, 22 issues, 1921, 49 issues.
Flying, 1913, 12 issues, 1915, 10 issues; 1917, 8 issues; 1918, 9 issues, 1920, 6 issues,
Aerial Age, 1915, 8 issues, 1916, 55 issues.

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